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AND

CHARLES ATWOOD KOFOID

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BY

JOSEPH GRINNELL AND TRACY I. STORER

A NEW BAT OF THE GENUS *MYOTIS* FROM THE HIGH SIERRA NEVADA OF CALIFORNIA

BY

HILDA WOOD GRINNELL

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BY

JOSEPH GRINNELL AND TRACY I. STORER

(Contribution from the Museum of Vertebrate Zoology of the University of California)

In our attempts to determine the systematic status of the mammals encountered in our natural history survey of the Yosemite section of the Sierra Nevada several of the forms prove to have been heretofore unprovided with names. It is the purpose of the present paper briefly to characterize these new races, so that names will be available for use in our distributional studies. Incidentally, related races in other faunal areas have to a limited extent come in for remark.

The color names herein employed are taken from Ridgway's *Color Standards and Color Nomenclature* (1912). All measurements, except of altitude, are in millimeters.

Scapanus latimanus campi, new subspecies

San Joaquin Mole

Type.—Male adult, skull and skin, in winter pelage; no. 21520, Mus. Vert. Zool.; Snelling, 250 feet altitude, Merced County, California; January 9, 1915; collected by Charles L. Camp; original no. 1746.

Diagnosis.—Resembles *Scapanus latimanus latimanus*, but smaller, pelage much paler and browner, feet and claws smaller, cranium shorter, brain-case more inflated anteriorly, rostral region less tapering, palatal region relatively wider, and supraoccipital ridge (posterior to interparietal) higher. Resembles *Scapanus latimanus occultus* in color, but decidedly larger in size, especially as regards feet and claws, cranium heavier and much bulkier, brain-case deeper, and supraoccipital ridge higher. Differs from *Scapanus latimanus sericatus* in much paler and browner color, claws shorter and blunter, cranium larger and broader, mastoid and interorbital breadths greater, and brain-case more inflated.

Material.—Three specimens from Snelling, Merced County, California (nos. 22004, 22005, 21250, Mus. Vert. Zool.); one specimen (injured skull and skeleton) from three miles north of Sanger, Fresno County, California (no. 18854, Mus. Vert. Zool.). Both these localities lie in the Lower Sonoran Zone.

Measurements (in millimeters)

No.	Sex	Total length	Tail	Hind foot
21250	♂	170	37	22
22004	♂	170	36	22
22005	♂ juv.	155	35	20

Remarks.—The imperfect specimen from Sanger, by Jackson (1915, p. 69) referred provisionally to *occultus*, seems to us to be better placed with the form here newly characterized. It seems likely that *campi* will be found to inhabit river-bottom lands of the San Joaquin Valley generally, at least on the east side.

The form is named for Mr. Charles Lewis Camp, in recognition of his ability as a field naturalist.

Martes caurina sierrae, new subspecies

Sierra Pine Marten

Type.—Male adult, skull and skin, in summer pelage; no. 22112, Mus. Vert. Zool.; head of Lyell Cañon, 9800 feet altitude, Yosemite National Park, California; July 24, 1915; collected by Charles D. Holliger; original no. 562.

Diagnosis.—Similar to *Martes caurina caurina*, but general coloration paler both above and below, this paleness involving both overhair and fur; sides of face decidedly paler; pale ochraceous-orange of chest very extensive, spreading forward to throat and backward along median line to belly; "feel" of pelage softer; cranium with rostrum short as in *caurina*, but extremely narrow; whole cranium narrower, and brain-case relatively higher; sagittal crest very weak; auditory bullae even smaller than in *caurina*.

Material.—Nine skins with skulls, some also with body skeletons, from various points in the Hudsonian Zone of the Yosemite National Park, Mariposa and Tuolumne counties, California.

Measurements (in millimeters)

						Cranium			
No.	Sex	Total length	Tail	Hind foot	Ear	Basilar length	Zygomatic breadth	Mastoid breadth	Height of brain-case at bullae
22109	♂	600	180	80	35	69.9	47.6	36.0	29.3
22110	♀	557	180	70	43	65.1	42.0	33.4	27.7
22111	♂	640	215	86	45	......	......	......	......
22112	♂	609	190	79	35	71.0	46.6	35.8	29.1
22113	♂	576	170	85	37	72.2	47.6	36.1	29.5
23040	♂	598	190	82	29	71.1	48.5	35.4	28.2
23041	♂ juv.	588	194	85	35	69.8	42.8	34.6	30.7
23042	♀	551	177	76	33	65.8	43.8	33.7	27.0
23043	♂	606	192	83	32	71.9	48.0	36.6	29.4

Remarks.—The Yosemite series of specimens, as regards both skins and skulls, is notably uniform in characters, and is doubtless representative of the race occupying the Boreal Zone along the whole Sierra Nevada, north at least to Mount Shasta. The specimens referred to *caurina* with some reservation by Miss Kellogg (1916, p. 356) should now be referred to *sierrae*. They are not typical of that race, however, showing departure in cranial characters towards *caurina* proper.

Eutamias amoenus monoensis, new subspecies

Mono Chipmunk

Type.—Male adult, skin and skull, no. 23380, Mus. Vert. Zool.; Warren Fork of Leevining Creek, 9200 feet altitude, Mono County, California; September 25, 1915; collected by J. Grinnell; original no. 3709.

Diagnosis.—Similar to topotypes of *Eutamias amoenus amoenus*, in corresponding pelage (post-breeding), but general tone of coloration paler, more grayish; top of head, central pair of light stripes on back, and rump, with proportion of white to red greater; ochraceous-tawny of sides paler; tips of dorsal tail hairs light buff rather than yellow-ochre; light middle portion of ventral surface of tail ochraceous-buff rather than ochraceous-tawny.

Material.—All from California: Twenty-one specimens from Mono County: Walker Lake, 8000 feet; Silver Lake, 7200 feet; Gem Lake, 9036 feet; Mono Craters, 7500–8000 feet; Williams Butte, 7000 feet; and Warren Fork of Leevining Creek, 9200–9400 feet; twenty-three specimens from Placer County: Cisco, 6000 feet; Soda Springs, 6500 feet; twenty-six specimens from Nevada County: Independence Lake, 7000 feet. These localities all lie in either the Canadian Zone or the upper part of the Transition Zone.

Remarks.—The form here described is the southernmost and palest representative of the *amoenus* group, occurring on the arid crest and east wall of the central Sierra Nevada, where it is characteristic of the Canadian Zone. Specimens from Independence Lake, Nevada County, indicate intergradation toward true *amoenus*. Measurements of total length, tail and hind foot, as tabulated by us (in MS), show no significant differences.

Fifteen topotype specimens of *Eutamias amoenus amoenus*, taken in the vicinity of Fort Klamath, Oregon, and loaned to us from the collection of the United States Bureau of Biological Survey, through Mr. E. W. Nelson, are in pelage comparable with our Mono series. These proved invaluable for demonstrating the differences distinguishing the race here newly named.

Eutamias merriami mariposae, new subspecies

Mariposa Chipmunk

Type.—Female adult, skull and skin, in full winter pelage; no. 21855, Mus. Vert. Zool.; El Portal, 2000 feet altitude, Mariposa County, California; November 24, 1914; collected by Walter P. Taylor; original no. 7099.

Diagnosis.—Similar to *Eutamias merriami merriami* in corresponding pelage, but general tone of coloration grayer, less brownish; dorsal pair of light stripes with ashy predominating; rump less brownish; sides much grayer, with but a trace of the ochraceous-buff of *merriami;* tail darker, the dorsal hairs banded and tipped with buffy white.

Material.—Fifteen specimens from the Upper Sonoran and low Transition zones of the west flank of the central Sierras of California: Madera County: Raymond, 940 feet; Mariposa County: three miles east of Coulterville, 3200 feet; El Portal, 2000 feet; Yosemite Valley, 4000–5000 feet.

Remarks.—The series at hand consists of specimens in either fresh or worn winter pelage, with but two exceptions. One of these exceptions, a juvenal, as compared with *merriami* of the same age, is decidedly paler and grayer, but not quite so gray as juvenals of *kernensis.* The other exception, our only specimen showing summer (post-breeding) pelage, is practically indistinguishable from *merriami* in the same coat. It is thus quite different from the grayish *kernensis,* though the tail is the same.

In our attempt to establish the systematic status of the *merriami* chipmunk of the Yosemite section, it was found that there exists an additional previously undescribed race of the same group in the Kern basin of the southern Sierras, and this is next described. Figure 1 is a map showing the distribution of all the Californian races of *Eutamias merriami* as illustrated by the material contained in the

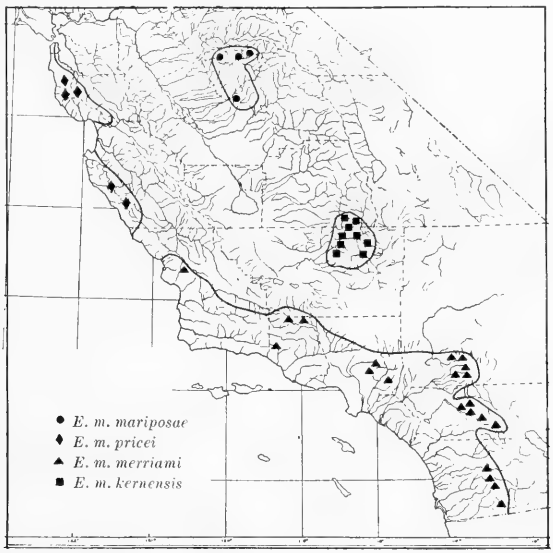

Fig. 1. Map showing ranges of four races of *Eutamias merriami* in central and southern California.

Museum of Vertebrate Zoology. This map, in conjunction with one recently published by the senior author (Grinnell, 1915) will serve to illustrate the ranges of all forms of the *townsendi-merriami* group now known to occur in California.

Eutamias merriami kernensis, new subspecies

Kern Basin Chipmunk

Type.—Male adult, skull and skin, in full summer (post-breeding) pelage; no. 15022, Mus. Vert. Zool.; Fay Creek, 4100 feet altitude, six miles north of Weldon, Kern County, California; July 13, 1911; collected by H. A. Carr and J. Grinnell; original no. 266.

Diagnosis.—Similar to topotypes of *Eutamias merriami merriami* in corresponding pelage, but decidedly grayer in general tone of coloration; sides of head and hind-neck ashy gray rather than leaden gray; dorsal light stripes relatively broad, more ashy in color; dorsal dark stripes narrower, and less richly brown in shade; sides pale tawny rather than reddish brown; dorsal tail hairs banded and tipped with light buff rather than ochraceous-tawny; ventral surface of tail, centrally, ochraceous-tawny rather than cinnamon-rufous.

Material.—Fifty-nine specimens from California as follows: Kern County: Kern River at Bodfish, 2400 feet; Kern River, twelve miles below Bodfish, 2000 feet; west slope Walker Pass, 4600 feet; Kern River at Isabella, 2500 feet; Kiavah Mountain, 7000 feet; Fay Creek, 4100 feet; Tulare County: Taylor Meadow, 7000 feet; Trout Creek, 6000 feet; Jordan Hot Springs, 6700 feet. These localities all lie in the Upper Sonoran and Transition zones.

Remarks.—Almost all of the specimens just mentioned are in full summer pelage. Their general grayness is conspicuous as compared with *Eutamias merriami merriami,* of which we have examined adequate topotype material from the San Bernardino Mountains. Unfortunately winter specimens of *kernensis* are entirely lacking, so that it is not possible to characterize the winter coat. A single July specimen showing delayed molt suggests extreme grayness in a degree comparable with that of the summer pelage.

Ochotona schisticeps muiri, new subspecies

Yosemite Cony

Type.—Male adult, skull and skin in winter pelage, no. 23480, Mus. Vert. Zool.; 9300 feet altitude near Ten Lakes, Yosemite National Park, Tuolumne County, California; October 11, 1915; collected by Walter P. Taylor; original no. 7720.

Diagnosis.—Fairly intermediate between *Ochotona schisticeps schisticeps* and *Ochotona schisticeps albatus;* general color more brownish than in *albatus,* but not so dark as in *schisticeps;* head distinctly different from back, leaden gray as contrasted with light brown; under surface of body and upper surface of feet pervaded with pale buff rather than either clay color or a creamy tint.

Material.—Fifty specimens from the Sierra Nevada in or near the Yosemite National Park, in Mariposa, Tuolumne and Mono counties, California. The various points of capture all lie within the Hudsonian and Alpine-Arctic zones.

Remarks.—The extensive series of conies now available from the Sierra Nevada points unmistakably to intergradation between *schisticeps* and *albatus* through the race here named *muiri*. Thus *albatus* should henceforth be designated trinomially. *Muiri* is, if anything, nearer to *schisticeps* of the Lake Tahoe region and northward than to *albatus* of the Mount Whitney region.

The new form here characterized is named for a gifted Sierran naturalist, the late John Muir.

Sylvilagus bachmani mariposae, new subspecies

Mariposa Brush Rabbit

Type.—Male adult, skin and skull; no. 21867, Mus. Vert. Zool.; adenostoma association, on McCauley Trail, at 4000 feet altitude, near El Portal, Mariposa County, California; December 7, 1914; collected by J. Grinnell; original no. 2972.

Diagnosis.—Similar to *Sylvilagus bachmani bachmani*, but general tone of coloration decidedly grayer, more black on back, ears larger, and cranium larger with longer and heavier rostral region; similar to *Sylvilagus bachmani cinerascens*, but grayer, especially on sides and ears, back with more black, general size greater, cranium with longer and heavier rostral region, and auditory bullae conspicuously smaller.

Material.—Six adult specimens from the Upper Sonoran Zone of the western Sierran foothills in Mariposa County, California, 800 to 4000 feet altitude.

Measurements (in millimeters)

No.	Sex	Total length	Tail	Hind foot	Ear from crown
21867	♂	326	30	73	80
21868	♀	342	27	75	80
22928	♀	340	32	71	—
22929	♂	340	25	75	80
23619	♀	280	25	75	75
23620	♂	313	32	74	74

Remarks.—The material at hand is probably representative of the race of *bachmani* occupying the "lower slopes of the Sierras between Shasta County and northern Tulare County," which Nelson (1909, p. 249) refers to as "not typical" but in his estimation "nearest to *bachmani*." The several distinctive characters displayed by our specimens seem to us to warrant fully the use of a separate name, especially in view of the apparent complete separation of the ranges of *mariposae* and *bachmani*. Intergradation between these two forms probably takes place through *cinerascens*, around the southern end of the San Joaquin Valley. The latter race, however, is not at all intermediate in characters, but is divergent from both, notably in the matter of the enlarged auditory bullae.

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A NEW BAT OF THE GENUS *MYOTIS* FROM THE HIGH SIERRA NEVADA OF CALIFORNIA

BY

HILDA WOOD GRINNELL

(Contribution from the Museum of Vertebrate Zoology of the University of California)

Eight species of bats were obtained in the summer of 1915 by the Museum collecting party working across the Sierra Nevada through the Yosemite region. These are found to include an apparently undescribed race of the Yuma bat, which is herewith characterized. Of particular note is the fact that this bat was ascertained to occur higher zonally than any of the others, two specimens having been taken by Dr. Walter P. Taylor at the upper edge of the Hudsonian Zone (Vogelsang Lake, 10,350 feet altitude).

Myotis yumanensis altipetens, new subspecies

High Sierra Bat

Type.—Male, adult; no. 23034, Mus. Vert. Zool.; 7500 feet altitude, one mile east of Merced Lake, Yosemite National Park, California; August 19, 1915; collected by J. Grinnell; original no. 3437.

Diagnosis.—Largest race of *Myotis yumanensis* occurring in California (total length 88 to 93 millimeters; greatest length of cranium 14.2 to 15.0 millimeters); coloration nearest that of *Myotis yumanensis sociabilis.*

Material.—Four specimens from the high Sierra Nevada, within the Yosemite National Park: two from Merced Lake, 7500 feet (Canadian Zone), and two from Vogelsang Lake, 10,350 feet (Hudsonian Zone).

MEASUREMENTS (IN MILLIMETERS)

No.	Sex	Total length	Tail	Foot	Ear	Forearm	Tibia	Greatest length of cranium	Weight (grams)
23034	♂	88	36	9	12	36.5	......	15.0	7.8
23035	♂	90	41	10	13	36.4	16.4	14.2	6.1
23036	♀	91	37	10	14	36.0	......	14.5	7.8
23526*	♂	93	40	11	15	36.0	16.6	......	7.2

*Alcoholic.

Remarks.—The fur of this bat is distributed as in *Myotis yumanensis yumanensis.* On the back the distal portion of the fur is isabella color and on the belly it is a pale tint of light buff. The skull differs considerably from skulls of other races of *Myotis yumanensis* from California. In addition to the greater size of the cranium, the brain-case is more inflated, and at the same time the depression between the brain-case and rostrum (in *altipetens*) is less marked than in the other subspecies.

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SPELERPES PLATYCEPHALUS, A NEW ALPINE SALAMANDER FROM THE YOSEMITE NATIONAL PARK, CALIFORNIA

BY
CHARLES LEWIS CAMP

UNIVERSITY OF CALIFORNIA PRESS
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SPELERPES PLATYCEPHALUS, A NEW ALPINE SALAMANDER FROM THE YOSEMITE NATIONAL PARK, CALIFORNIA

BY
CHARLES LEWIS CAMP

(Contribution from the Museum of Vertebrate Zoology of the University of California)

One of the results of the Yosemite Natural History Survey recently carried on under the auspices of the California Museum of Vertebrate Zoology is the discovery of a new salamander from the high Sierra Nevada. This alpine species is apparently most nearly related to some of the forms of *Spelerpes* inhabiting the central Mexican plateau and Mount Orizaba, and constitutes an interesting addition to the Pacific fauna, inasmuch as this genus has not hitherto been recorded from west of New Mexico. The present species appears to be one of a number of forms far removed geographically from the center of abundance of the genus, and its locality of occurrence makes it seem likely that the boreal salamanders of this group had a much wider range during glacial times than at present. One is led to expect that other species of *Spelerpes* may yet be found in western America, particularly in the higher regions of northern Mexico.

Spelerpes platycephalus, new species

Mount Lyell Salamander

Type.—Female, adult, no. 5693, Mus. Vert. Zool.; head of Lyell Cañon, 10,800 feet altitude, Yosemite National Park, California; July 18, 1915; collected by C. L. Camp; orig. no. 2215.

Diagnosis.—Body elongate; tail shorter than head and body; palatine teeth in two slightly arched series, separated from the parasphenoid patches and extending beyond the choanae; head broad and depressed; tongue attached to central pedicel only, free in front; digits half-webbed, 4–5; costal folds 12; color dark chocolate, mottled on back, sides, limbs, feet, tail and chin with gray.

Material.—Two adults from the type locality, as above: nos. 5693 female, and 5694 male, Mus. Vert. Zool.

Comparisons.—The free tongue, consolidated premaxillaries, ossified parietals, and digits 4–5 place the present species within the genus *Spelerpes.* The half-webbed toes and character of the palatine teeth relate it more closely to the Mexican alpine forms of that genus than to those of the tropical and austroriparian regions of North America. In number of costal folds and style of coloration (see Brocchi, 1882, pl. 19), it resembles *S. leprosus* Cope (1869, pp. 105–106), described from the "Alpine region, in Vera Cruz, Mexico." But it is distinct from *leprosus* because of its wider and longer head and shorter tail (see table of measurements).

MEASUREMENTS IN MILLIMETERS OF *SPELERPES*

	S. platycephalus			*S. leprosus*		
	no. 5693 ♀		no. 5694			
	alive	in alcohol	♂	♂[1]	♀[1]	sex ?[2]
Total length	106.5	99.4	86.9	91	105	87
Tail from posterior angle of vent	35.5	33.6	30.2	45	52	37
Head width	11.9	10.3	10.2	8	9	8
Snout to gular fold	15.3	14.2	12.6	....	....	....
Snout to axilla	......	20.7	18.4	....	....	15
Snout to groin	......	54.2	47.8	....	....	46
Fore limb	16	15.5	15.5	12	14	15
Hind limb	18	17.0	16.9	15	17	18

[1] Boulenger, 1882, p. 68.
[2] Cope, 1869, p. 106.

Description of type.—Parasphenoid teeth in two elongate patches, separated by a narrow interval from the palatine teeth which extend in two slightly arched series beyond the choanae; head depressed, wider than body at any point; no trace of canthus rostralis, subnarial protuberances or parotoid glands; naso-labial grooves barely distinguishable; nostrils minute; premaxillaries united, containing a fontanel; maxillary and mandibular teeth small and numerous, jaws not edentulous posteriorly; body elongate, containing distance from snout to gular fold four and one-half times; limbs fail to meet by two costal interspaces, when appressed to sides; fore limb forward to middle of eye; hind limb forward over five costal folds; fingers and toes slightly enlarged at ends, webbed about half way to tips, inner digit rudimentary, smaller than outer on both front and hind foot; tail much shorter than body, cylindrical; eyes small and far apart; extended tongue 30–40 millimeters long; gular fold continuous with a line running to eye; costal folds 12.

Color in life dark chocolate, marked evenly and thickly on back and sides of head and body, on limbs, feet and tail, and below chin with lichen-like gray markings, yellowish in tinge down middle of back, where less distinct, and bluish on sides; underparts posterior to gular fold uniform dark chocolate. Iris bright yellow. In alcohol the yellowish tints have disappeared.

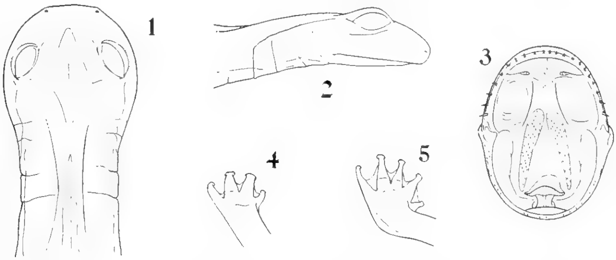

Fig. 1.—Top of head, ♀ no. 5693, Mus. Vert. Zool.; note great breadth of head, and distance between eyes.

Fig. 2.—Side of head, ♀ no. 5693, Mus. Vert. Zool.; note small nostril, relative size of eye, position of gular fold, and lines on side of neck.

Fig. 3.—Open mouth of ♂ no. 5694, Mus. Vert. Zool.; note tongue, unattached in front, character of palatine and parasphenoid teeth, and long maxillary teeth.

Fig. 4.—Left fore foot, ♂ no. 5694, Mus. Vert. Zool.; note extent of webbing.

Fig. 5.—Left hind foot, ♂ no. 5694, Mus. Vert. Zool.; note extent of webbing, and enlarged ends of toes. All $\times 2\frac{1}{3}$.

Variations.—The only other specimen, a male, differs somewhat from the type. The teeth on the sides of the upper jaw (see fig. 3) are abnormally long, protruding below the closed lips beneath the eyes, and are few in number (ten on each side); the body is shorter, the appressed limbs being separated by only one costal fold, and the light markings are smaller and more scattered.

Remarks.—The two Mount Lyell salamanders were taken on the rocky, snow-covered north slope of Mount Lyell, in the Yosemite National Park, about a mile from the glacier and a little below timber line, here marked by a few stunted white-bark pines on the tops of the ridges. The exact spot was at the 10,800-foot contour, on a steep, east-facing hillside above the Donohue Pass trail in a small patch of heather. A stream close by issued directly from the snow banks and disappeared beneath rock-slides below. The two specimens were found to have been captured simultaneously in a spring-clip mouse-trap set in front of a small hole running into the moist soil beneath some rocks.

Transmitted August 25, 1916.

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A NEW SPERMOPHILE FROM THE SAN JOAQUIN VALLEY, CALIFORNIA, WITH NOTES ON *AMMOSPERMOPHILUS NELSONI NELSONI* MERRIAM

BY
WALTER P. TAYLOR

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BY
WALTER P. TAYLOR

(Contribution from the Museum of Vertebrate Zoology of the University of California)

Accumulation of specimens of antelope chipmunks (genus *Ammospermophilus*) from the San Joaquin Valley, California, is now sufficient to permit a review of their systematic status, and this review demonstrates the existence of a new subspecies, herewith described, in the vicinity of Los Baños, Merced County. Occasion is taken also to comment on the distribution of *Ammospermophilus nelsoni nelsoni*, to make a contribution to its life-history, and to discuss its economic relations.

The writer desires to thank Dr. Joseph Grinnell and Mr. Harry S. Swarth, of the staff of the Museum of Vertebrate Zoology, for helpful suggestions.

Ammospermophilus nelsoni amplus, new subspecies
Los Baños Antelope Chipmunk

Type.—Male adult, in summer pelage; no. 16693, Mus. Vert. Zool.; 20 miles south of Los Baños, Merced County, California; June 20, 1912; collected by R. H. Beck; orig. no. (J. Grinnell) 1957.

Diagnosis.—Similar to *Ammospermophilus nelsoni nelsoni* but larger, paler colored, and with white lateral lines less distinct.

Comparison.—Summer skins of *Ammospermophilus nelsoni amplus* are paler than those of *A. n. nelsoni.* Their dorsal coloration approximates light buff, almost whitish on nape of neck and sides of face, while in *nelsoni* the hue is close to light pinkish cinnamon, approaching whitish back of ears. A tendency is observable in *amplus* to have the white of the lateral stripes a little obscured by an admixture of light buffy hairs, particularly towards the rump. In *nelsoni* the stripes are purer white. The general pallor of *amplus* also renders the white stripes less conspicuous. The white eye-ring is also less prominent in *amplus* than in *nelsoni.* The pure coloration of the upper surface of fore and hind limbs tends toward pinkish buff in *amplus,* more towards light pinkish cinnamon in *nelsoni,* although in certain examples no difference in hue is appreciable. There seems to be a tendency in *amplus* toward a flatter tail than in *nelsoni.* The coloration of the tail seems also to be more clearly disposed in bands than it is in *nelsoni,* in which the tail dorsally is more indiscriminately mixed, blackish and whitish.

There are no conspicuous cranial differences between the two forms. Certain crania of *Ammospermophilus nelsoni amplus* average 2.7 per cent longer than in *A. n. nelsoni,* mastoid width about 3.0 per cent greater, and nasals about 9.8 per cent longer.

Difference in size usually furnishes a comparatively conspicuous character. Total length in *Ammospermophilus nelsoni amplus* averages 9.6 per cent above the average in *A. n. nelsoni;* length of tail vertebrae, 5.4 per cent, length of hind foot, 6.0 per cent, and length of ear, 40.8 per cent. Unfortunately the length of ear cannot be measured, by the methods used, accurately enough to be as reliable as are the other measurements.

With two exceptions the specimens of *Ammospermophilus nelsoni amplus* are in summer pelage. Two examples (nos. 13816, 13817, Mus. Vert. Zool.), taken March 25 and March 27 respectively, are in winter coat. The pelage in winter is softer and thicker than in summer, and is more grizzled or spotty; hues of coloration are paler, and the white stripes on the sides less conspicuous. One of the examples (no. 13816) is inclined more toward grayish or whitish; the other (no. 13817) is more yellowish.

Distribution.—Of *Ammospermophilus nelsoni amplus* there are 34 specimens (including three skeletons-only) in the Museum of Vertebrate Zoology, representing two localities, as follows: Sweeney's Ranch, 22 miles south of Los Baños, California, 2; mouth of Little Panoche Creek, 18 or 20 miles south of Los Baños, 32.

Remarks.—Although *Ammospermophilus nelsoni amplus* is a well-marked form, it is sufficiently close to *A. n. nelsoni* to be referred to the same species. According to present records there is a gap between the ranges of the two from about the vicinity of Huron, Fresno County, northward to a point within 18 or 20 miles of Los Baños, Merced County; but it is not improbable that wide-spread collecting in the region of this seeming gap would demonstrate continuous distribution and geographic intergradation.

Measurements.—Of the type: Total length, 260 mm.; tail vertebrae, 75; hind foot, 43; ear, 7; greatest length of skull, 43.1; mastoid width, 21.6; interorbital constriction, 10.5; length of nasals, 13.1.

Males average slightly larger than females. External measurements of 15 males: Total length, 249 mm. (max. 267, min. 234); tail vertebrae, 73.1 (max. 78, min. 66); hind foot, 41.3 (max. 44, min. 40). Corresponding measurements of 16 females: Total length, 238 (max. 256, min. 230); tail vertebrae, 72 (max. 78, min. 67); hind foot, 40 (max. 43, min. 37).

External measurements of 31 adults, combining both males and females: total length, 243.6 mm. (max. 267. min. 230); tail vertebrae, 72.5 (max. 78, min. 66); hind foot, 40.6 (max. 44, min. 37).

Crania of four males: Greatest length of skull, 42.2 mm. (max. 43.1, min. 41.5); mastoid width, 21.4 (max. 21.6, min. 21.2); interorbital constriction, 10.2 (max. 10.5, min. 9.9); length of nasals, 12.4 (max. 13.1, min. 12.2). Corresponding measurements of three females: Greatest length of skull, 40.1 (only one specimen measured); mastoid width, 21.1 (max. 21.7, min. 20.5, two specimens measured); interorbital constriction, 9.7 (max. 10.2, min. 9.2); length of nasals, 12.0 (max. 12.5, min. 11.6, two specimens measured).

Cranial measurements of seven adults, combining both males and females: Greatest length of skull, 41.8 (max. 43.1, min. 40.1); mastoid width, 21.3 (max. 21.7, min. 20.5); interorbital constriction, 9.9 (max. 10.5, min. 9.2); length of nasals, 12.3 (max. 13.1, min. 11.6).

NOTES ON THE DISTRIBUTION AND LIFE HISTORY OF *AMMOSPERMOPHILUS NELSONI NELSONI*

Distribution.—This species was first made known by Dr. C. Hart Merriam in 1893 (pp. 129–131). That its distribution is general in the southern San Joaquin Valley is indicated by the accompanying map (see fig. 1). Actual records, as published by Merriam, pertain to the following localities: Tipton (type locality), Tulare County; Alila (now known as Earlimart), Tulare County; Huron, Fresno

County; Adobe Station, Kern County (see Palmer, 1893, p. 362); Lerdo, Kern County; Poso, Kern County (see Palmer, 1893, p. 378); Lake Buena Vista, Kern County; Temblor (or Temploa) Mountains, on boundary between Kern and San Luis Obispo counties. The following additional stations of occurrence, ascertained by the Museum of Vertebrate Zoology, may now be added: Eight miles northeast of

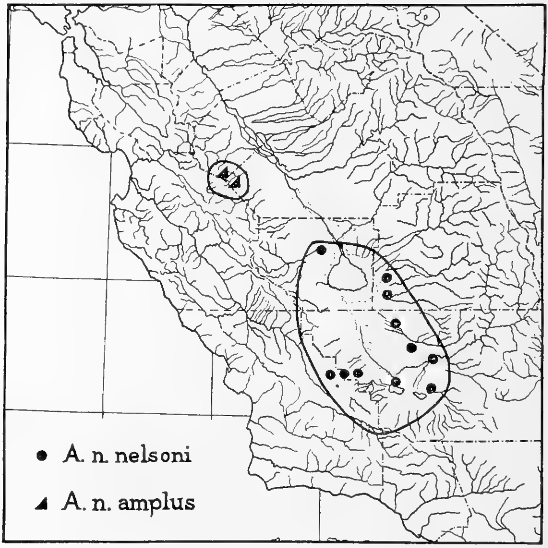

Fig. 1.—San Joaquin Valley, California, with outlines of ranges of *Ammospermophilus nelsoni amplus* and *Ammospermophilus nelsoni nelsoni*. Dots represent localities where specimens have been collected.

Bakersfield, Kern County; McKittrick, Kern County; and Carrizo Plains, seven miles southeast of Simmler, San Luis Obispo County. In 1912, Grinnell (MS) noted many antelope chipmunks in the Cuyama Valley, extreme southeastern San Luis Obispo County.

General habits.—Antelope chipmunks were found in abundance by our Museum party eight miles northeast of Bakersfield, where the animals preferred the open, exposed tracts covered chiefly with foxtail grass. They were noted also in Atriplex country both in the vicinity of Bakersfield and in the neighborhood of McKittrick, where sandy washes seemed to be fairly well occupied. Near Bakersfield the antelope chipmunks were found in the hilly regions only, none at all being noted on the plains below. They do not, however, so far as available data indicate, range above the Lower Sonoran zone. Their call-notes were not loud, being, in fact, indicated more by the associated convulsive movement of the body than by the sound itself. During the cool of the morning the animals were not in evidence, appearing only after it became quite warm. Apparently six or eight individuals constituted a colony of average size. The sides of little gullies were often fairly honeycombed with burrows, such situations on banks being preferred, perhaps, to any other location. The burrows investigated proved to be somewhat complicated, two or three passageways running into one at a depth of a foot or more below the surface. This passageway, in turn, joined one or two other aggregations of entrance ways. Although several burrows were dug out to the end, no nests or food-stores were discovered. The cheek pouch of a specimen from McKittrick (no. 9032, Mus. Vert. Zool.), contained 745 seeds of *Erodium* (either *moschatum* or *cicutarium*).

Breeding habits.—Adult males (taken May 7 to 28) had testes enlarged, signifying reproductive activity. Two juvenal specimens were collected, a male (no. 13824, Mus. Vert. Zool.), May 7, 1911, eight miles northeast of Bakersfield, and another (no. 13850, Mus. Vert. Zool.), May 18, 1911, at McKittrick. No embryos were found, so probably the young had been born during April or very early in May, or perhaps even earlier.

Economic relations.—The Nelson chipmunk seems to prefer barren situations which have no agricultural importance. The possibility of its doing damage by burrowing through the walls of irrigating ditches or by eating the seeds of cultivated plants is remote. The experience of the Museum party, and of other observers with related species (for example, see Mearns, 1907, pp. 300 and following), supports the conclusion that the members of this group of spermophiles (*Ammospermophilus*) are of little or no economic importance.

Possible effect of farming on the status of the species.—No antelope chipmunks could be found in the vicinity of the type locality, Tipton, Tulare County, the first noted being observed some 30 miles to the south. Residents acquainted with the species testified that it formerly occurred where now it is absent. Possibly farming activity crowds out *Ammospermophilus*. Residents also asserted that the Beechey ground squirrel is a comparatively recent immigrant into the lowlands of the San Joaquin Valley, and that it is continually increasing in numbers. Possibly the immigration of *Citellus beecheyi* tends to assist in the crowding out of *Ammospermophilus nelsoni* and the consequent restriction of the range of the latter. Much more evidence, however, must be gathered before any degree of probability can be assumed for the suggestions here made.

Transmitted April 21, 1916.

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HABITS AND FOOD OF THE ROADRUNNER IN CALIFORNIA

BY

HAROLD C. BRYANT

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CONTENTS

INTRODUCTION

Investigations of the food habits of birds have of late done more to afford birds proper protection than any discussion from a purely esthetic point of view. It seems to the writer, however, that the pendulum may have swung a little too far in the direction of the dollars-and-cents view and that the esthetic is being left too far in the background. Even to the economic ornithologist who is busy determining the money value of birds there comes a vision of a day when all true values will be taken into account and the monetary factor will be given only its due share of consideration. Nevertheless, it is natural to emphasize the point of view which at the moment makes the greatest appeal, and that at the present time appears to be the economic.

The esthetic worth of the roadrunner (*Geococcyx californianus*) is great and should not be altogether overshadowed by other considerations. Every early settler in California was quickly informed of the *paisano* (''the countryman''), a bird which could run faster than a horse, just as surely as he was informed of the ''sacred toad'' (horned toad), which wept tears of blood. The vaquero whose horse was fast enough to overtake a roadrunner so that it could be lassoed boasted of the fact for weeks. In fact, the roadrunner adds interest and charm to every region where it is found. Recognition is, therefore, given to this and to other inherent values even though they be not emphasized in this paper.

Because the roadrunner is conspicuous in size and action gunners have used it as a mark. The added incentive to kill this bird because of its alleged habit of destroying the eggs and young of the valley quail, a favorite game bird, has been instrumental in practically exterminating it in many localities in this state. Whether or not the food habits of the roadrunner have justified this treatment has not heretofore been adequately considered. The protection afforded the bird in California has thus far rested wholly upon the few general statements regarding its food habits and upon the recognition of its esthetic value. The present investigation has been carried on with the aim of providing a sounder basis either for its protection as a valuable species or for its destruction as an injurious species.

MATERIAL

Eighty-four stomachs of roadrunners collected in southern California, most of them in San Diego County, have been available for examination. This material was obtained in 1911 and 1912, when the California Fish and Game Commission was gathering information as to the food habits of the western meadowlark. This paper is, therefore, an additional report on the investigation then begun by the Commission. The material embraced birds taken in every month of the year with the exception of March. General complaint has been made against the roadrunner that it is destructive of the eggs and young of valley quail. Positive evidence on this point was sought by collecting the largest number of birds during the nesting season of quail. The deputies of the Fish and Game Commission who collected the birds were instructed to take them in localities where quail were nesting and where positive evidence as to their bird-eating habits could therefore be obtained. Deputy Webb Toms of San Diego, who obtained the largest number of specimens, reported as follows: "I commenced to collect roadrunners April 19, 1912, during which month I obtained two. From May 1 to June 16, fifteen were procured. All of those which I obtained during the nesting season were taken where quail and other birds were nesting." The entire number of birds secured should suffice to furnish fairly complete evidence as to the food habits of the roadrunner during the nesting season. The alleged habit of destroying quail made it necessary to investigate the food of the roadrunner in uncultivated districts as well as in those in which the species comes in contact with civilization.

If the food habits of a bird found more abundantly in this state were to be considered, a larger number of stomachs would be requisite for examination, but the comparative rarity of the roadrunner did not justify the killing of more individuals than seemed absolutely necessary.

The material was handled and the same method (percentage-volume) used as is described in a previous paper on the economic status of the western meadowlark (*Sturnella neglecta*) in California (H. C. Bryant, 1914, pp. 395–420). As in previous work, the attempt has been made to furnish comparable data to all interested by using a combination of the European and American methods. The tables showing the number of birds taking the different items of food will allow British economic ornithologists to compare readily the food habits of the roadrunner with those of British birds. On the other hand, the use of the percentage-volume method as developed by the United States Biological Survey will furnish the data to which economic ornithologists in America are accustomed.

My sincere thanks are due Miss Anna M. Lute of the Bureau of Plant Industry, United States Department of Agriculture, for the identification of seeds found in the stomachs. Professor Charles W. Woodworth and Professor Edwin C. Van Dyke, of the Department of Entomology in the University of California, have determined for me, or verified the identification of, different species of insects, and to them also I desire to make grateful acknowledgement. Mr. Donald R. Dickey and Mr. William L. Finley kindly allowed the use of excellent photographs, for plates 1 and 2. Mr. Tracy I. Storer, Assistant Curator of Birds in the California Museum of Vertebrate Zoology, has assisted in making photographs for illustration, and Director Joseph Grinnell, of the same Museum, has put at my disposal

apparatus and information which has been of great help. He has also critically read the manuscript and offered suggestions.

LIFE-HISTORY AND HABITS

Although most birds are found to possess at least some interesting characteristics, there are very few which have so many outstanding peculiarities as has the roadrunner (*Geococcyx californianus*). Four marked characteristics distinguish this bird. First, although classified with the cuckoos, it has no close relatives, other than the slightly different Mexican roadrunner (*Geococcyx affinis*), living in North America at the present time; second, it is probably the fastest endurance runner among California birds; third, it has peculiar nesting habits; and fourth, its diet is most extraordinary.

No better proof of the fact that the roadrunner has long excited keen interest among people can be offered than that numerous stories have grown up which attribute more than ordinary intelligence to this bird. The commonest story, and one often implicitly believed, is to the effect that the roadrunner has an ingenious method of killing a rattlesnake, a feat which it takes every opportunity to perform. This myth has even crept into scientific writings (Heermann, 1859, p. 61; Orcutt, 1886, p. 49; Van Dyke, 1897, pp. 36–38; Cooper, 1870, p. 369). The following version has been put on record by the ornithologist Walter E. Bryant (1891, p. 60):

> It is said that when the roadrunner finds a rattlesnake coiled and asleep, it corrals him or builds a fence around him of the cactus burrs with their innumerable sharp spines. After completing the corral it then commences to tease and worry the snake by darting at and pecking it with its stout bill. The snake in endeavoring to extricate himself from his thorny enclosure finds himself pricked on every side by the sharp spines of the cactus, and tantalized by the bird becomes infuriated, bites himself, and dies.

Furthermore, the many local names of the roadrunner show it to be a well-known bird wherever found. In addition to the name "roadrunner", which is probably a translation of the Spanish name *correo del camino,* it is variously called chaparral cock, ground cuckoo, *paisano* (Spanish for "countryman"), lizard bird, and snake bird. Practically all of these names emphasize some peculiar characteristic of this bird.

So unusual is the general appearance of the roadrunner that field marks are readily employed as a means of identification. The legs are long and powerful; the tail is as long as the body and rounded at the end, and the outer tail feathers are tipped with white; the crest when raised is conspicuous, as is also the bare skin about the eye, which is red, blue, and whitish in color. The bill is over two inches long and hooked at the tip. The plumage is conspicuously striped with buffy brown and white and on the back and tail is glossed with green. At close range it will be noted that two toes point forward and two backward, a character which has caused this bird to be classified along with the cuckoos. The character of the feet make the footprints along a dusty road readily recognizable.

There is no bird in the arid southwest that is more characteristic of the chaparral belt and desert. Most abundant in the San Diegan and desert regions, the roadrunner becomes less numerous toward the northern limit of its range in Shasta County. North of the Tehachapi it is most common in the foothills of the Sierras. It has been recorded twice from the humid coast belt north of San Francisco Bay, in Sonoma and Marin counties (Mailliard, 1900, p. 63; Belding, 1890, p. 56); and it approaches the coast in Alameda County (near Oakland) and in San Mateo and Santa Cruz counties. It has been found rarely in the San Joaquin Valley. A few exceptions are noted: A roadrunner was noted at Tranquillity, Fresno County, on June 22, 1915 (H. C. Bryant, MS). This individual sought refuge among tules, an out-of-the-ordinary habitat for this bird. One was seen by Tyler (1913, p. 82) at Lane's Bridge, Fresno County, December 6, 1905, and a few others near Fresno at other times. In the mountains of southern California the roadrunner is occasionally seen above 5000 feet; but at or above this altitude it is always on some hot slope where Upper Sonoran vegetation is in evidence. Cooper (1870, p. 77) reported the species as occurring on Catalina Island in the early 60's, but no additional records of its occurrence on the islands off the coast of California are known. A study of the distribution of the roadrunner shows that the area inhabited follows very closely the limits of the Upper and Lower Sonoran life-zones (Grinnell, 1907, pp. 51–53).

It is not obvious how the range of the species is affected by its limited powers of flight, but the range of the individual is probably comparatively extensive, due to its highly developed powers of pedal locomotion. Where the individual range of most song-birds can be computed as covering but a few acres, that of the roadrunner in all probability needs to be computed in square miles.

The breeding season usually covers the months of March, April, and May. A nest placed in a cholla cactus and containing four eggs was found by Kelsey (1903, p. 132) in Cholla Valley, San Diego County, March 25, 1903, and Sharp (1907, p. 87) found eggs advanced in incubation as early as February at Escondido in the same county. Another nest containing three nearly full-fledged young was discovered in a mesquite bush by Stephens (MS) at Salton, Imperial County, as early as April 17, 1909; and a nest containing three fresh eggs was found as late as July 16, 1904, by W. M. Pierce at Claremont, Los Angeles County (Willett, 1912, p. 54). The foregoing instances include the earliest and latest nesting dates recorded for this state.

Although the roadrunner is largely terrestrial, it seeks safety for eggs and young by placing its nest well above the ground. Some thorny shrub or cactus is usually selected and the nest is placed from three to ten feet above the ground (plates 1 and 2). Shepardson (1915, p. 159) records having found one nest at an elevation of twenty feet in a willow tree and another, in 1915, twelve feet above the ground in a pepper tree growing in a well-populated section of the city of Los Angeles. The nest itself is constructed of sticks loosely laid together. A slight lining of finer material is to be found, almost invariably composed of dry horse manure more or less broken up. A cast-off (molted) snake skin, and feathers are also frequent adjuncts. In approaching the nest the roadrunner usually ascends the cactus or other shrub in which the nest is placed, by hopping from limb to limb, seldom attempting to fly directly to the location.

The eggs number from three to nine and are deposited at intervals of several days. Both male and female help during the incubation period, which lasts about eighteen days (Bendire, 1895, p. 17). Incubation is apparently begun when the first eggs are laid, for we have considerable evidence that fresh eggs, small young, and fledglings are found in the nest at the same time. Bendire (1878, p. 39) calls attention to this habit in the following words:

> In 1872, while in southern Arizona, I found some twenty nests of *Geococcyx californianus*, the first nest on April 8, the last on September 10. During the month of April, in which I found several nests, not one contained more than three eggs, although I allowed incubation to begin before taking the eggs, as I expected the birds to lay more. Nearly every nest I found after the middle of May contained four or five eggs, and I account for the greater number laid late in the season by the fact that insect food during the dry season, which includes April and May, is comparatively scarce. The birds being aware of this content themselves with rearing a small brood the first time, and a large one at the second laying, when the young are hatched about the beginning of the rainy season, which sets in in June. At this time all

kinds of insects and reptiles become exceedingly abundant, and the birds have less trouble in providing for a family of five than earlier in the season for one of three. Only occasionally have I found eggs in different stages of incubation, and I do not believe that there was over a week's difference in the time of laying of the eggs in any nests I found.

No further evidence is at hand that more eggs are laid at a second nesting later in the season. In fact, this seems rather improbable. There is additional evidence, however, that eggs and young are often found in the nest at the same time. Coues (1903, pp. 606–607) states that perfectly fresh eggs and newly-hatched young may be found together; and by the time the last young are breaking the shell the others may be graded up to half the size of the adult. The Finleys (1915, p. 162) found a nest in Arizona which contained one fresh egg, one egg just ready to hatch, "two featherless, greasy, black young," and two young ones about ready to leave the nest. Morcom (1887, p. 41) records the finding of a young roadrunner and two eggs in which incubation was advanced in a nest in San Gorgonio Pass, Riverside County, California, on May 27, 1886.

The young are described as "most hideous" in aspect. Their coal-black skin and ungainly form combine to make them more or less repulsive. When nestlings are disturbed they attempt to frighten the intruder by making a clicking noise with their bills.

The habits of the roadrunner are of peculiar interest. The following account to be found in the report of one of the early exploring expeditions (Heermann, 1859, pp. 60–61) emphasizes its speed in running:

We found this bird throughout California, frequenting at times the most arid portions of the country. It often crossed our path, or ran before us for a short distance on the road, dashing, when alarmed, immediately into the chaparral, where, swift of foot, it easily evaded pursuit. It may, however, be overtaken when followed on horseback over the vast open plains where no friendly bush offers the weary bird a shelter. When closely chased, if on an elevated point, it will sometimes fly, but always sailing downward. I once saw one captured by a couple of dogs, their appetites whetted by recent success in overtaking and bringing down a coyote or prairie wolf. Hotly pressed, the bird would gain upon his enemies while sailing down the mountain slope, but taking to his feet on the first ascent, this advantage was again soon lost, and the fugitive, worn out, fell at length a victim to their relentless determination.

H. W. Henshaw (1876, p. 257) states that the long tail of the roadrunner, when running at full speed, is lowered till its end almost touches the ground, and that the bird seems to fairly glide over the earth, so easy are its movements. When hurrying, the tail is used in turning quickly, being thrown from side to side with a jerk, according to the direction to be taken. On gaining the cover of bushes, the bird's safety seems assured, and it usually pauses in the first cover and stands with head erect, the tail vibrating nervously while it holds itself in readiness to recommence its flight.

As a rule, this bird is shy and suspicious, but its inquisitiveness sometimes so overcomes this character that it appears tame and confiding. The species is not at all gregarious, no more than single individuals or pairs being ordinarily seen at one time.

Roadrunners kept in captivity by Sutton (1915, p. 58) refused to bathe in water, but continually took dust baths. The operation is described thus: "Shaking all over, and creeping along the ground by flapping their wings inwardly, they make the dust fly into all their feathers."

The small amount of water needed for sustenance probably accounts for the fact that this species thrives on the hottest deserts where the nearest water is several miles distant. In captivity the roadrunner rarely drinks more than twice a week. When thirsty long measured draughts are taken and the breast is dampened by the proceeding (Sutton, 1915, p. 60).

Quick of action, the roadrunner is expert in catching its prey, be it insect, lizard or mouse. When pursuing insects the bird will often leap into the air eight or ten feet and catch them on the wing.

The commonest note of the roadrunner is a low "*br-r-r-r-r*," which does not carry to any great distance. More often the only sound to be heard from the bird is a snapping of the mandibles. During the nesting season a sort of song much like the cooing of a dove is regularly heard. This song is thus described by Holterhoff (1883, pp. 182–183):

Standing near the summit of the hillock amidst his favorite cactus, and with outstretched neck and head bent down, he would utter, as if by prodigious effort, the lugubrious notes I had wrongly thought the cooing of the dove. At each iteration of the cry he seemed to make a renewed effort as if to rid himself of the troublesome "whooo," and when finished would stand motionless, perhaps marveling at the sweetness of his own voice, or more likely awaiting a response.

These peculiar notes of the roadrunner sound, as near as I can word it, much like the prolonged syllable *whooo*—aspirating strongly the *wh* and giving the vowel as a soft guttural. This note—not so prolonged as the "coo" of the dove—is repeated some five or six times in distinctly separate utterances . . .

A roadrunner makes an amusing and interesting pet and in early days in California this bird was often kept about the house and garden and was used as a destroyer of insects and mice. Some interesting accounts of these pets are to be found in literature.

FOOD OF THE ROADRUNNER IN CALIFORNIA

Vegetable Food

About 10 per cent, 9.93 per cent to be exact, of the food of the roadrunners examined was found to be made up of vegetable matter, wild fruit and seeds being most in evidence. Unlike many birds which turn their attention to vegetable food during the winter season, the roadrunner appears to discriminate as to the kind of seeds taken. The percentage volume of one particular kind of vegetable food was found to be over ten times as great as of all others. This favorite food is the fruit and seeds of the sour-berry (*Rhus integrifolia*), one of the common sumacs of the southern part of the state. Twenty-six birds, or 31.3 per cent of the stomachs examined, contained the seeds or fruit of this shrub, and 8.4 per cent of the food taken by all the birds was made up of this element. The attention of the roadrunner is apparently attracted to this vegetable food only during the winter season, when insects, lizards, and other kinds of food are least abundant.

No other fruit was found, and the only other seeds were atriplex (*Atriplex* sp.), 0.01 per cent; cactus (*Opuntia* sp.), 0.35 per cent; buckthorn (*Rhamnus* sp.), 0.01 per cent; and a few seeds of alfilaria (*Erodium* sp.). Indeed, so small a percentage of seeds other than the seeds of sumac and cactus were found that it may be that these small seeds were taken into the stomach along with other food and were not in reality chosen by the bird. The same can be said in regard to the small rootlets and grass sometimes found in the stomachs, which amounted to less than a tenth of 1 per cent. Attention has been called (Bendire, 1895, p. 14) to the fact that the roadrunner eats the fruit of cactus, but in the stomachs examined nothing but the seeds of the opuntia was found.

Even though limited to desert and arid regions, a much wider variety of fruit and seeds is available than is taken, as has been shown by the results of stomach examination. The logical conclusion, therefore, is that a preference has been established, by southern California roadrunners at least, for the fruit and seeds of the sour-berry (*Rhus integrifolia*).

Animal Food

The animal food of the roadrunner, which made up slightly over 90 per cent of the total food, is varied, perhaps as varied as that of any common species of bird. Almost any animal, from the smaller

TABLE I

Numbers of Food Items Taken by Fifteen Roadrunners During Winter Months, November, December, January

	Beetles	Wireworms	Grasshoppers	Crickets	Stenopelmatus	Cutworms	Diptera	Hemiptera	Hymenoptera	Arachnida	Crustacea	Reptiles	Birds	Mammals	Miscellaneous
January	17	....	....	....	....	10	....	....	....	....	....	....	....	....	....
"	....	....	3	....	....	....	....	....	....	....	....	....	?	....	1
"	12	....	....	2	....	....	....	....	....	1	....	....	....	....	....
"	1	....	1	8	....	....	....	....	....	....	....	....	....	....	....
"	8	....	....	3	....	....	....	....	....	....	....	....	....	....	1
November	7	10	....	....	8	....	....	....	....	....	....	....	....	....	....
"	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....
"	16	....	2	....	....	3	....	....	....	....	....	....	....	....	....
"	4	....	2	....	....	....	....	....	....	....	....	....	....	....	....
"	5	....	18	....	....	....	....	....	....	....	....	....	....	....	....
December	1	....	6	....	....	....	....	....	4	1	....	....	....	....	....
"	2	....	....	....	....	....	....	....	....	....	....	....	....	....	4
"	1	....	3	....	....	....	....	....	....	1	....	....	....	....	....
"	1	1	1	....	....	....	....	10	....	....	....	....	....	....	....
"	13	....	9	1	....	....	....	....	....	....	....	....	....	....	1
Totals	88	11	45	14	8	13	....	10	4	3	....	1	....	....	7

Average number of items per bird—13.6.

Numbers of Food Items Taken by Fifteen Roadrunners During Summer Months, June, July, August

	Beetles	Wireworms	Grasshoppers	Crickets	Stenopelmatus	Cutworms	Diptera	Hemiptera	Hymenoptera	Arachnida	Crustacea	Reptiles	Birds	Mammals	Miscellaneous
June	2	....	3	....	....	....	....	8	....	....	....	....	....	....	....
"	8	....	5	....	1	....	....	5	....	....	....	....	....	....	1
"	1	....	4	....	....	....	....	....	1	....	....	....	....	....	....
"	6	....	....	....	....	....	....	....	....	....	....	....	....	....	....
"	9	....	1	1	....	....	....	....	....	....	....	....	....	....	....
July	....	....	1	3	....	....	....	....	....	....	....	....	....	....	....
"	1	....	63	....	....	....	1	....	....	....	....	....	....	....	....
"	....	....	3	....	....	....	....	....	1	....	....	....	....	....	1
"	1	....	26	1	....	....	....	1	....	....	....	....	....	....	....
"	....	....	2	19	....	....	....	....	....	....	....	....	....	....	....
August	....	....	1	10	....	5	....	....	....	2	....	....	....	....	....
"	4	....	6	1	....	....	....	....	....	....	....	....	....	....	....
"	....	....	....	27	....	....	5	....	....	....	....	....	....	....	....
"	39	....	....	5	....	....	....	....	1	1	....	....	....	....	....
"	4	....	2	4	....	2	....	....	250	1	....	....	....	....	....
Totals	75	....	117	71	1	7	6	14	253	4	....	....	....	....	2

Average number of items per bird—36.2.

rodents down to tiny insects, appears to be relished by this bird. Although the stomachs examined showed no large percentage of vertebrates, other published records show that reptiles sometimes form a large part, if not the entire diet. Even these larger elements of food are usually swallowed whole at one gulp. That the digestive apparatus is powerful is evidenced by the fact that bone, hair, and feathers pass through the digestive tract, and are not thrown back out through the mouth in the form of pellets as is the case with some hawks and most owls.

Beetles.—Beetles form next to the largest percentage of the animal food of the roadrunner. Over 18 per cent (18.20 per cent) of all the food of the roadrunners examined was made up of beetles of different sorts. Since this bird is a ground-loving species, ground beetles of various sorts are most often taken, more than sixty having been found in a single stomach (see pl. 4, fig. 4). Such injurious beetles as the click-beetles and wood-borers were also found in numbers in the stomachs. Beetles are apparently taken in largest quantity during the winter months, a total of eighty-eight having been found in the food of fifteen birds during November, December, and January, as against seventy-five in that of the same number of birds during June, July, and August (see table I). The following species of Coleoptera were identified:

Beetles (Coleoptera)

Amara californica Dej.	Coniontis sp.
Amara insignis Dej.	Coniontis elliptica (Casey)
Amara sp.	Silpha ramosa Say
Eleodes sp.	Scyphophorus yuccae Horn.
Lixus sp. (near pleuralis Le Conte)	Rhynchitidae
Lixus sp.	Anisodactylus dilatatus Dej.
Eleodes acuticauda Le Conte	Crossidius intermedius Ulke
Microschatia inaequalis Le Conte	Epicauda puncticollis Mann.
Centrocleonus pilosus Le Conte	(?) Pterostichus sp.
	Asida sp.
	Sphenophorus sp.

Grasshoppers and crickets.—About one-third of the animal food and almost one-fourth of the total food for the year was found to be made up of grasshoppers (21.2 per cent). In addition, black crickets (*Gryllus* sp.) made up 12.62 per cent and Jerusalem crickets (*Stenopelmatus*) an additional 3 per cent, making Orthoptera a total of 36.82 per cent of the food. Grasshoppers and crickets were taken at all times of the year, but were most evident in the diet during the summer and fall months (see table I). The largest number of grasshoppers found in any one stomach was sixty-three. Many stomachs contained between twenty-five and thirty. More individuals had fed upon Orthoptera than upon any other group of insects (see table III). Orthoptera, it can be seen therefore, make up the basic element of the food of the roadrunner. The following species of Orthoptera were identified:

Grasshoppers and Crickets (Orthoptera)

Mantidae
 ?Litaneutria pacifica Scud.
Gryllidae
 Gryllus pennsylvanicus Burm.
 Gryllus integer Scud.
Locustidae
 Stenopelmatus irregularis Brun.
 Stenopelmatus sp.

Acridiidae
 Melanoplus differentialis Uhler
 Melanoplus devastator Scud.
 Melanoplus sp.
 Schistocerca sp.
 ?Paropomala sp.

Hollister (1908, p. 458) reports that he found the stomachs of two roadrunners obtained near Needles, California, filled with "large green grasshoppers." A specimen taken by Stephens (MS) near San Diego, November 5, 1908, was also found "crammed with grasshoppers." In fact, so apparent has been the fact that the roadrunner feeds extensively on grasshoppers that practically every writer has included these insects in statements regarding its food (see table II). So far as relative quantity per bird is concerned, the roadrunner is probably to be numbered among the most efficient destroyers of these familiar pests.

Butterflies and moths.—The fact that butterflies and moths usually escape attack by birds has again been demonstrated by this investigation. Only a little over one-half of 1 per cent of the food examined was made up of adult butterflies and moths. Two noctuid moths were taken from one stomach, one from another, and a nymphalid butterfly from a third. Lepidopterous larvae, on the other hand, formed 7 per cent of the food taken. One stomach contained as many as thirty-six caterpillars. Three birds had taken woolly-bear caterpillars (*Eustigmene acreae*), another a white-lined sphinx caterpillar (*Celario lineata*), and a third a pupa of *Hemileuca* sp. Hairy caterpillars of some species of *Malacosoma* were also found.

The roadrunner shows relationship with the cuckoos in its habit of destroying hairy caterpillars. The stomach of a roadrunner taken at Otay, San Diego County, April 19, 1912, contained seven large

TABLE II

FOOD OF THE ROADRUNNER ACCORDING TO PUBLISHED RECORDS

	Cactus	Fruit	Insects	Beetles	Grasshoppers	Crickets	Caterpillars	Bugs	Centipedes	Spiders	Land mollusks	Snails	Batrachians	Reptiles (not specified)	Lizards	Snakes	Mammals (not specified)	Rodents (not specified)	Rats	Mice	Birds
A. W. Anthony, 1896, p. 257; 1897, p. 217	....	....	....	....	....	....	×	....	....	....	....	....	....	....	....	....	....	....	×	....	....
F. M. Bailey, 1902, p. 195	....	....	....	....	×	×	×	....	×	....	....	....	....	....	....	×	....	....	....	....	....
Baird, Brewer and Ridgway, 1874, p. 474	....	....	×	×	×	....	....	....	....	....	....	....	....	×	....	....	....	....	....	....	....
C. Bendire, 1895, p. 14	×	....	....	×	×	....	....	....	....	....	....	×	....	....	×	×	....	×	....	....	×
C. Bendire, 1878, p. 39	....	....	×	....	×	....	....	....	....	....	....	....	....	....	×	....	....	....	....	×	....
Wm. Brewster, 1883, p. 26	....	....	....	×	×	....	....	....	....	....	....	....	....	....	×	×	....	....	....	....	....
J. G. Cooper, 1870, p. 369	....	....	×	....	....	....	....	....	....	....	....	....	....	....	×	×	....	....	....	....	....
E. Coues, 1903, pp. 606–607	....	×	×	....	....	....	....	....	....	....	×	....	....	×	....	....	×	....	....	....	×
O. Davie, 1889, p. 205	....	....	....	....	....	....	....	....	....	....	....	....	....	....	×	×	....	....	....	....	....
W. K. Fisher, 1904, p. 80	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	×
Grinnell, J., and Grinnell, H. W., 1907, p. 35	....	....	....	....	....	....	....	....	....	....	....	....	....	....	×	....	....	....	....	....	....
A. J. Grayson *in* W. E. Bryant, 1891, p. 58	....	....	....	....	×	....	....	....	....	....	....	....	....	....	×	....	....	....	....	×	....
A. L. Heermann, 1859, pp. 60–61	....	....	....	×	×	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
H. W. Henshaw, 1876, p. 257	....	....	×	....	....	....	....	....	....	....	....	....	....	×	×	....	....	....	....	....	....
N. Hollister, 1908, p. 458	....	....	....	....	×	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Knowlton & Ridgway, 1909, p. 449	....	....	....	×	×	....	....	....	....	....	....	×	....	....	×	×	....	×	....	....	×
D. E. Lantz, 1907, p. 51	....	....	....	....	....	....	....	....	....	....	....	....	×	×	....	....	....	×	....	×	....
F. Miller, 1879, p. 109	....	....	....	×	....	....	....	×	....	×	....	....	....	....	×	×	....	....	....	....	....
J. S. Newberry, 1857, p. 51	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
C. H. Richardson, MS	....	....	....	×	×	....	....	....	....	....	....	....	....	....	×	....	....	....	....	....	....
R. W. Shufeldt, 1903, p. 177	....	....	....	....	....	....	....	....	....	....	....	....	....	....	×	....	....	....	....	....	....

hairy caterpillars (*Pseudohazis* sp.), and at least four other birds had taken from three to four hairy caterpillars apiece, but not of the same species. One of the spiny type of caterpillar (*Euvanessa antiopa*) had been taken by a breeding female collected at El Toro, Orange County, on May 18, 1912. One instance of the destruction of caterpillars by the roadrunner, recorded by Anthony (1897, p. 217) is of peculiar interest:

> Not long since I called on a friend living in the suburbs of San Diego who had a large number of unusually thrifty passion-vines climbing over his fence. Upon inquiring the reason of their freedom from what I had considered an inevitable pest, he informed me that a pair of roadrunners (*Geococcyx californianus*) had for several months paid daily visits to his vines, climbing through them in all directions until the last caterpillar (*Agraulis vanillae*) had been captured.

Flies.—The only representatives of the order Diptera found were two green-bottle flies (*Lucilia caesar*), a few robber flies and a syrphid fly; these latter were undetermined as to genus or species. In addition, two stomachs contained quantities of fly larvae, those in one stomach being probably larvae of some species of *Musca*. Hundreds of these larvae were found in one stomach. The stomach of a roadrunner from the Imperial Valley contained the larva of a warble fly (*Cuterebra* sp.).

Bugs.—Five per cent of the total food was found to be made up of hemipterous insects. Instead of a wide variety having been taken, it was found that the birds examined had been largely choosing cicadas (*Cacama crepitans*), insects which are close relatives of the seventeen-year locust of the eastern United States. Cicadas formed 4.3 per cent of the total food. Certain stomachs were completely filled with these insects, as many as thirty-six having been taken from a single bird (pl. 4, fig. 5). Eleven birds, or 13.2 per cent of all of those examined, had fed upon this insect to some extent. The next most abundant hemipteron was the cabbage-bug (*Mergentia histrionica*), ten having been taken from a single stomach. The latter and other bugs (*Euschistus* sp.; *Anasa* sp.) made up less than 1 per cent of the total food.

Ants, bees, and wasps.—A little over 4 per cent of the total food was made up of ants, bees, and wasps. Several bumblebees (*Bombus* sp.), three carpenter bees (*Ceritina* sp.), and several ichneumon flies were items taken by several birds. The stomach of a roadrunner secured August 7, 1912, at Chula Vista, San Diego

County, contained over 250 red ants (*Pogonomyrmex californicus*), along with a quantity of caterpillars, crickets, beetles, and grasshoppers. Another bird taken in October had eaten ten carpenter ants (*Camponotus* sp.). One roadrunner had taken a tarantula hawk (*Pepsis* sp.), and two had each taken a single honey bee (*Apis mellifera*). The following species of hymenoptera were identified:

Ichneumonidae	Apis mellifera Linn.
Bombus vornesenskii Rad.	Chrysis sp.
Ceratina sp.	Pogonomyrmex californicus Buck.
Pepsis sp.	Camponotus sp.

Spiders and scorpions.—Spiders composed about 0.7 per cent of the total food. A number of birds had taken the egg-cases of spiders and one bird, taken August 1, 1911, at Sorrento, San Diego County, had had the courage to devour a tarantula (*Avicularia californica ?*).

One of the outstanding features of the diet of the roadrunner in California seems to be the presence of scorpions; these make up about 3.67 per cent of the total food. The commonest species found in the stomachs was *Anuroctonus phaeodactylus*. Fourteen birds had taken scorpions and the remains of as many as four were found in a single stomach. Probably no other bird in California feeds so widely on this particular arthropod.

Centipedes and millipedes.—Both centipedes (Chilopoda) and millipedes (*Julus* sp.) were found in the stomachs, but they formed but a very small percentage, much less than 1 per cent, of the total food.

Crustaceans and snails.—Sowbugs (*Porcellio* sp.) were found in but one stomach. No further evidence that crustaceans were eaten was forthcoming. McCall (in Baird, Brewer and Ridgeway, 1874, II, p. 474) states that in Texas snails are greedily eaten by the roadrunner: "These are usually taken either from the ground or a branch, and carried to a particular spot, where the shell is broken and its contents eaten. Piles of these shells are often found thus collected in places frequented by them." No snails were found in the stomachs examined by the present writer.

Toads and frogs.—Stomach examination gave no evidence that any amphibian had been eaten. Toads were commonly eaten by tame roadrunners kept by Sutton (1915, p. 59), but it is doubtful if these vertebrates are taken by roadrunners under natural conditions.

Lizards and snakes.—About 3.7 per cent of the total food was found to be made up of reptiles. Except in one instance, lizards alone had been taken. They were of the following species: Uta (*Uta stansburiana*), blue-bellied lizard (*Sceloporus biseriatus*), and Blainville horned toad (*Phrynosoma blainvillei blainvillei*). None of the birds examined had eaten more than one lizard.

The following additional evidence that the roadrunner in California feeds upon lizards is at hand: On July 9, 1894, near Pasadena a roadrunner was secured, the stomach of which contained four full-sized whip-tailed lizards (Grinnell, 1907, p. 35). C. H. Richardson (MS) secured a roadrunner at Mecca, Riverside County, March 22, 1910, which contained, besides grasshoppers and beetles, a horned toad, presumably of the desert species (*Phrynosoma platyrhinos*). The stomach of a roadrunner taken at Needles, California, February 15, 1910, contained one weevil, remains of other beetles, and a half-grown lizard (*Cnemidophorus*), the latter digested to the bare skeleton (Grinnell, MS).

Finley and Finley (1915, p. 164) found that a roadrunner in Arizona which they had under observation fed its young almost entirely upon lizards. They write:

> While we were crouching at the peephole of the blind the mother came, carrying a big lizard, grasped firmly in her bill (plate 3). Up the bark she scratched and thrust the lizard, head down, into the mouth of the youngster. The tail hung out of its bill for a long time, but something had hold of it down below, and finally it all disappeared. Soon she came with another lizard, and presently another youngster was sitting propped stiffly with a tail hanging out of its mouth. Again came a lizard—and again—and again—there was no use counting. The larder was full of lizards and nothing else!

Mr. Leo Wiley of Palo Verde, Imperial County, reports that he has seen roadrunners carrying whip-tailed lizards and utas about, although he has never actually seen the birds eat them. All evidence points to the fact that the whip-tailed lizard (*Cnemidophorus*) is the lizard most often eaten. Whether the abundance of this species is responsible for this fact or whether a preference is indicated is not apparent.

Very little attempt to break a lizard to pieces seems to be made by the roadrunner. Instead, the reptile is usually swallowed whole head first, after being hammered to death on some hard object nearby. How the bird which had eaten the Blainville horned toad mentioned above could have swallowed this reptile, which was fully an inch wide, even when compressed, I am not able to say. But it appears that the throat of the bird must have power of expansion similar to that exhibited by snakes.

The finding of a piece of the skin of a red-racer (*Bascanian constrictor frenatum*) in the stomach of a roadrunner taken at Palo Verde, Imperial County, alone gave evidence that snakes form part of the diet. Although the present investigation furnishes but little evidence that snakes are fed upon, yet the following records further establish the fact that they are sometimes taken. A roadrunner captured in New Mexico contained a garter snake a foot long (Bailey, 1902, p. 195); and Bendire (1895, p. 14) records the taking of a garter snake twenty inches long from the stomach of a roadrunner secured in Arizona. Mr. E. A. Goldman reported to me that the stomach of a roadrunner which he secured in California contained several young rattlesnakes. However, the idea that the roadrunner is an active enemy of the rattlesnake is probably exaggerated. Rattlesnakes may occasionally be eaten along with other snakes, but that they are particularly sought out is extremely doubtful.

In this habit of feeding upon reptiles the roadrunner is almost unique among birds, with perhaps the exception of certain hawks and owls.

Birds.—Birds amounted to 1.7 per cent of the total food of the roadrunners examined. The only evidence which showed that the roadrunner feeds upon birds of any sort was that obtained through the finding of the remains of a young Anthony towhee (*Pipilo crissalis senicula*) and that of an Abert towhee (*Pipilo aberti*). No evidence is at hand to determine whether these birds were taken alive from the nest or secured after they had died. In the first instance the body had been badly mutilated and the main parts left for identification were the feet. The Abert towhee was taken from the stomach of a roadrunner secured at Palo Verde, Imperial County. In this instance the bird had been swallowed whole.

W. K. Fisher (1904, p. 80) states that an assistant of Professor Leroy Abrams of the department of botany, Stanford University, observed a roadrunner remove from a nest a young mockingbird and devour it. Anthony (in Bendire, 1895, p. 14) says: "I know of several instances of roadrunners making a meal of a nest of young house finches (*Carpodacus mexicanus frontalis*) and other small birds." Beyond these instances we have no further information as to the bird-eating habit among roadrunners, except the fact that birds in captivity readily devour young sparrows or other birds furnished as food. A roadrunner kept at the State Game Farm at Hayward, California, greedily devoured young sparrows and dead downy pheasants.

Inquiries as to the destruction of young quail or eggs by the roadrunner have elicited only the following information: Peter Lux, of Encinitas, San Diego County, California, writes that he and his brother saw a roadrunner catch and eat young quail at Olivenhain about June 1, 1903. Mr. Lux also states that since that time (about four years ago) he saw a young quail carried to a roadrunner's nest and fed to the young. Mr. George Wood, of Hollywood, California, writes as follows:

> In the month of June, 1906, I was making a study of the cause of the death of so many young mockingbirds. I came on a nest containing two young roadrunners, about two weeks old, and just at the moment of finding the nest I also saw the male roadrunner with a young quail in its mouth. It saw me and ran away. I got back under cover and watched until it returned and I saw it take a young quail to the nest. I saw it return the second time and repeat the above.

Mr. Leo Wiley of Palo Verde, Imperial County, recently told the writer in a conversation that during the first part of August, 1915, he saw a male roadrunner kill six Gambel quail which were about four days old. The roadrunner gave each one a single blow with its bill and, leaving the one just killed, attacked another.

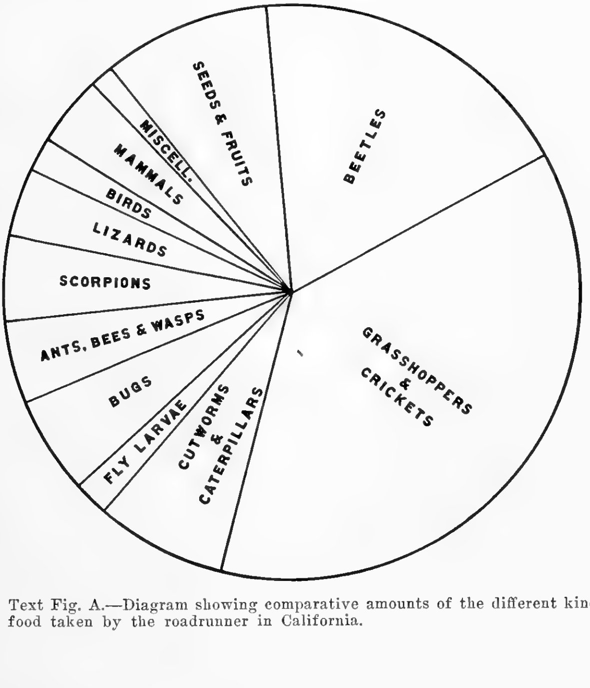
Throughout the Imperial Valley it is rumored that the roadrunner destroys hens' eggs and young chicks. Mr. Walter E. Packard, in charge of the Imperial Valley Agricultural Experiment Station, writes: "I have heard a great many rumors to the effect that the roadrunner sucks eggs, but I do not know of any instance where the bird has been caught in the act or where it has been proven that this bird was guilty of such an act. Nor can I refer you to anyone who could give you information in this regard." These accusations, therefore, apparently rest on circumstantial evidence.

Such limited evidence as the above, unsupported as it is by the results of stomach examination, would go to show that the habit of destroying the eggs and young of birds is probably greatly exaggerated and that the eggs and young of birds are only incidentally taken by the roadrunner. Certainly the evidence at hand here in California does not justify the wholesale destruction of the roadrunner on the ground of its being an enemy of quail or other bird life.

Mammals.—Judging from stomach examination, 3.38 per cent of the food of the roadrunner in California is made up of mammals. Three different species were found in the stomachs: a harvest mouse (*Reithrodontomys megalotis longicaudus*), a white-footed mouse (*Peromyscus* sp.), and a newly-born San Diego cottontail rabbit (*Sylvilagus auduboni sanctidiegi*).

Professor F. E. L. Beal procured a roadrunner in California which had eaten a meadow mouse (*Microtus californicus*) (Lantz, 1907, p. 51.) That even larger mammals are sometimes destroyed is evidenced by the following observation made by A. W. Anthony (1896, pp. 257–258):

> This forenoon (May 7, 1896) I came suddenly upon a roadrunner (*Geococcyx californianus*) that had just finished dispatching a wood rat (*Neotoma*). The bird reluctantly withdrew as I came upon the scene, leaving the rat, which I found to be quite dead. A post-morten disclosed a bad contusion on the side directly over the heart, and another on the spine between the shoulders, while the skull was crushed by a blow behind the ear, although the skin was nowhere broken.



Text Fig. A.—Diagram showing comparative amounts of the different kinds of food taken by the roadrunner in California.

KINDS AND QUANTITIES OF FOOD ITEMS

The principal items of food as shown by this investigation and the relative percentage volume of each are indicated in the accompanying figure (text fig. A). The outstanding feature is the preponderance of insect food. The roadrunner is primarily insectivorous, both vegetable and vertebrate food forming minor elements. So far as bulk is concerned, the amount of grasshoppers and crickets taken was double the amount of beetles and these elements taken together formed more than half of the total food.

TABLE III

NUMBERS AND PERCENTAGES OF ROADRUNNERS TAKING DIFFERENT KINDS OF FOOD

Rhus integrifolia	Erodium	Atriplex	Opuntia	Rhamnus	Seeds?	Roots and Grasses	Beetles	Wireworms	Grasshoppers	Crickets	Stenopelmatus	Lepidoptera
26	2	1	5	1	4	3	62	4	52	23	11	4
31.3	2.4	1.2	6.0	1.2	4.8	3.6	74.7	4.8	62.6	27.7	13.2	4.8

Cutworms and Caterpillars	Diptera	Dipterous Larvae	Miscellaneous Hemiptera	Cicadas	Hymenoptera	Arachnida	Scorpions	Centipedes	Millipedes	Crustacea	Reptiles	Birds	Mammals
15	4	2	5	11	22	8	14	2	2	2	4	2	4
18.2	4.8	2.4	6.0	13.2	26.5	7.2	16.8	2.4	2.4	2.4	4.8	2.4	6.0

A tabulation (table III) of the number of birds taking the different elements of food is helpful in showing preference. It will be seen that this table verifies the conclusions already made as a result of the percentage-volume method. About three times as many birds had taken beetles, grasshoppers and crickets as had taken any other insect. Of the birds examined but four had taken reptiles, the same number had taken mammals and but two had taken birds; the material in one of these instances was doubtfully identified as being the intestines of a bird. The fact that fourteen birds had taken scorpions indicates that this invertebrate is a fairly common element of food in the diet of the roadrunner. The table shows no other distinct preference for a certain element of food.

PECULIARITIES OF THE DIET

The omnivorous food habits of the roadrunner have been amply demonstrated by the above results of stomach examination, yet it is desirable that some of the peculiarities of the diet be emphasized. As has already been stated, one of the outstanding features is the apparent preference for one sort of vegetable food, the seeds and fruit of a certain sumac. Furthermore, the roadrunner apparently turns its attention toward terrestrial vertebrates to a larger extent than does any other California bird, with the exception of the raptorial birds. As a destroyer of reptiles this bird probably takes first rank among all the birds, and without doubt in many places in this state the roadrunner is the worst natural enemy to which lizards and snakes are exposed.

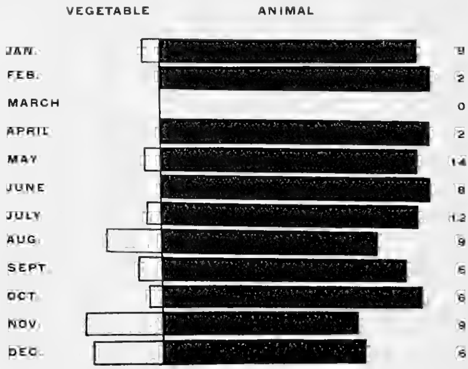
Many poisonous species of insects are eaten by the roadrunner. The scorpion is perhaps the most conspicuous example. In many instances the poison sac was found still attached to the tail of the scorpion inside of the roadrunner's stomach. No evidence was obtained that ill effects are sustained by the bird from the poison. Bumblebees come in the same category, as does also the single tarantula hawk taken. The latter is known to inflict a very painful sting. If such insects as the latter were carefully killed by the bird before being eaten, danger of being stung internally would be eliminated, but the poison would still be present. A partial explanation of the lack of ill effects may be that the poison is kept entirely within the alimentary tract of the bird and has but little chance to enter directly into the blood.

That the roadrunner has great ability in stalking rapid-flying insects is illustrated by the fact that great quantities of cicadas are consumed (see pl. 4, fig. 5). Entomological collectors state that cicadas are difficult to capture. A record of thirty-six cicadas in a single stomach certainly shows that this bird is adept in securing certain insects which other birds are not so successful in securing in quantity. Probably the roadrunner relies upon its ability to stalk the insects rather than upon its speed on foot.

It is highly probable that the roadrunner destroys more hairy caterpillars than does any other bird in the state of California. Stomach examination has given abundant evidence that this bird preys systematically upon these insects. The hairyness of a woolly-bear caterpillar appears to be an effective protection to it in most instances, but three of the roadrunners examined had eaten this insect. The

California cuckoo, whose food habits are largely unknown, probably displays this same habit of eating hairy caterpillars, as do other cuckoos. But this species is so rare in California that its work in comparison to that of the roadrunner must be slight.

The stomachs of two roadrunners each contained a praying mantis, an insect seldom found in birds' stomachs, perhaps because of its comparative rarity. An ant lion (*Myrmelion* sp.) had been eaten by one bird. A hairworm (*?Gordius* sp.) was found in one stomach, but as this stomach also contained grasshoppers it is probable that this parasitic worm originally may have been contained in one of these insects.



Text-Fig. B.—Diagram showing the average percentage of vegetable food (in white) and animal food (in black) consumed by the roadrunner in California during the various months of the year. Numbers at the right indicate the number of stomachs used in making the average.

VARIATION OF FOOD ACCORDING TO TIME OF YEAR

As is the case with most birds, the roadrunner is forced to vary its food from one part of the year to another. In the winter when insects become scarce vegetable food is resorted to. As can be seen by a study of text-fig. B, but small amounts of vegetable food are taken during the season when insects are abundant. A comparison of the actual numbers of insects taken by fifteen roadrunners during the summer months with those taken by the same number of birds during the winter months (table I) shows that during the summer season the roadrunner consumes on an average over twice as many insects as it does during the winter months. No noteworthy seasonal change in the kinds of insects taken is evidenced by the tabulation.

STOMACH CAPACITY

An average full stomach of a roadrunner contains about ten cubic centimeters of food. The maximum quantity found in a stomach was about forty cubic centimeters. This means that nearly two quarts of food are needed weekly if the stomach were filled to an average distension three times a day, and that a single bird probably consumes in a year something like one hundred quarts. The fact that single stomachs could contain over sixty ground beetles, sixty-three grasshoppers, or thirty-six large cicadas makes it evident that, so far as the amount of food consumed is concerned, the roadrunner approaches front rank among the common land birds. At first thought such a capacity would seem to increase the ability of the bird to do good or harm. This is in a measure true, but the much smaller number of individuals of this species compared with certain gregarious species of birds makes it possible that certain birds with much smaller stomach capacity, because of the greater number of individuals, may consume even more. The stomach capacity of the individual roadrunner is great, but that of the total roadrunner population is relatively small.

Variety in the diet, as well as typical elements of the food, is well illustrated by the following tabulation of the stomach contents of a single roadrunner taken at Lemon Grove, San Diego County, January 21, 1913:

Vegetable, 3%

2 seeds (*Rhus integrifolia*)	2 grass-blades
1 seed with stem (*Erodium* sp.)	

Animal, 97%

6 beetles (*Amara insignis*)	1 bug (*Euschistus conspersus*)
1 beetle (*Eleodes acuticauda*)	8 bugs (*? Anasa* sp.)
5 beetles (*Microschatia inaequalis*)	1 scorpion (*Anuroctonus phaiodactylus*)
5 beetles (*Centrocleonus pilosus*)	1 spider egg-case
8 wireworms (Elateridae)	1 lizard (*Uta stansburiana*)
12 grasshoppers (*Melanoplus* sp.)	
1 Jerusalem cricket (*Stenopelmatus* sp.)	

ECONOMIC STATUS

The investigation of the stomach contents of eighty-three roadrunners taken in southern California revealed but little evidence that the roadrunner is injurious to man's interests. The following, all of minor importance, form the most important evidence against the bird: Parts of an Anthony towhee found in one stomach; a very young

San Diego cottontail rabbit found in one stomach; three lizards, considered beneficial as insect destroyers, taken by three different birds; and two honey bees found in different stomachs. Certain of the carabid beetles found might by some be considered sufficiently beneficial to warrant their preservation, but little is yet known of the food habits of even the commonest ground-beetles destroyed by the roadrunner, namely, the different species of *Amara*. Until more is definitely known it cannot be said that the destruction of these beetles by birds is distinctly detrimental.

The above adverse evidence is minimized in most instances by the demonstrated fact that these elements of food are out-of-the-ordinary, rather than staple items, for they form very small percentages of the food for the year. This is not true, however, in regard to lizards, for they form a staple article of diet. Should it be proved that lizards are strictly beneficial as insect destroyers, this habit of feeding on lizards might, according to present standards, serve to incriminate the roadrunner. However, until conclusive evidence shows that the roadrunner actually reduces in numbers the scaly denizens of the desert and in so doing is an adverse factor to insect control, we are not justified in assuming that the lizard-eating propensities of this bird place a serious blot on its character.

The stories regarding the bird-eating habits of the roadrunner appear to have some foundation in fact, but much of the evidence submitted has been of the circumstantial kind, and with little doubt some statements have been grossly exaggerated. The frequent assertion that roadrunners commonly destroy the eggs and young of the valley quail has not been substantiated by this investigation. No evidence whatever has been obtained that they destroy the eggs of quail or those of any other bird. That they do sometimes destroy young quail and other young birds appears to be true, but statements to the effect that such destruction is carried on systematically or that young birds form a staple article of diet have not been verified. Furthermore, our evidence fails to show that quail suffer destruction to a greater extent than do other birds. In any case, the bird-eating habit appears to be individual rather than general.

Evidence pointing toward the usefulness of the roadrunner as a valuable destroyer of insects and possibly of rodents, wherever it comes in contact with civilization, was obtained as a result of the investigation. Chief among the items of food the destruction of which must be considered a benefit are: Grasshoppers, crickets, Jerusalem crickets, wireworms, and hairy caterpillars. The regular consumption of such large numbers of grasshoppers by roadrunners must in some measure affect the abundance of the insect. The increase or decrease in the numbers taken by the roadrunner according to whether the insect is scarce or plentiful makes it probable that this bird, wherever it is found, acts as one of the checks on grasshopper abundance. Jerusalem crickets, commonly known as "potato bugs," and black crickets, although of less economic importance, are classified as injurious insects. Wireworms are important insect pests in cultivated fields, and their destruction by natural enemies is to be encouraged rather than discouraged. Artificial means of destroying wireworms are limited and the work of birds is therefore more potent. As there are practically no vertebrate enemies of hairy caterpillars, and since to this group of caterpillars belong many destructive larvae, their systematic destruction by the roadrunner goes far towards establishing it among those birds to be classed as beneficial. Add the possible benefit conferred through the destruction of small rodent pests, and the evidence in favor of protecting the bird exceeds the evidence against it.

Economic ornithologists have many times called attention to the fact that so far as apparent results are concerned the work of birds in destroying insects is not so effective as an artificial method such as the use of an insecticide. True it is, also, that birds less often attack those injurious insects for the control of which large amounts of money are spent than those which must be classified as of minor importance. For instance, here in California, according to statistics compiled by the Agricultural Experiment Station, about nineteen times as much money is spent each year on the control of black and other scales, phylloxera and codling moth, as is spent on all other insects combined. Hence the commonest insects eaten by birds—grasshoppers, cutworms and caterpillars, and wireworms—are of much less economic importance and their destruction by birds appears to be of less significance. Nevertheless, many of the workings of nature are still beyond our knowledge and we are constantly finding out that artificial methods are usually inferior to natural ones. May it not be that the very reason why such insects as grasshoppers, cutworms, and wireworms are of minor importance is that they are better controlled by natural agencies? Certainly most of the insects of minor economic importance are potentially as destructive as those for the control of which great sums of money are spent. Indeed, the constant attempts to find and introduce some natural enemy of the more injurious insects is proof that where the natural control is lacking the most energy must be expended towards filling the need.

It must be granted that the roadrunner, like all others under natural conditions, helps to maintain the balance of nature. And even if its work in the destruction of economically important insects is apparently of a less degree of importance, it should be remembered that the bird may be performing a service which we cannot measure, and that the systematic destruction of any of the natural enemies of insects may be instrumental in increasing the economic importance of that insect.

It is only when the roadrunner comes in contact with settled communities that it can be said to be injurious, unless it be proved that the number of quail accessible to the hunter is materially reduced. Since most of the roadrunners are confined to desert regions far from the haunts of men, the total harm done is much smaller than would be the case with species more abundant in settled country. Then, too, both the possible damage and the potential good are greatly minimized by the fact that there is no concentration of individuals at any one time or place. The number of roadrunners in any one locality does not vary greatly and is always relatively small. Probably the maximum numbers per square mile do not exceed ten or twelve even in favorable localities.

SUMMARY

The roadrunner (*Geococcyx californianus*) is unique in many ways. Of particular interest are its breeding habits and especially food habits. It is doubtful if an investigation of the food habits of any other American bird could have yielded such unusual and interesting results.

The investigation here reported upon included the analysis of eighty-four stomachs of roadrunners taken in southern California in 1911 and 1912 and also a survey of all available literature relative to the food of the roadrunner in California. The stomachs became available as a result of the inquiry into the food habits of non-game birds instituted by the California Fish and Game Commission in 1911.

The eighty-four stomachs represented birds taken every month of the year with the exception of March. The analysis of the stomach contents showed that practically 90 per cent (90.07 per cent) of the

total food was made up of animal matter and that slightly less than 10 per cent was of vegetable material. Nearly all of the vegetable matter was of one kind, the fruit and seeds of the sour-berry (*Rhus integrifolia*). Insects and certain vertebrates composed the animal food. Chief among the insects found were beetles (18.2 per cent), grasshoppers and crickets (36.82 per cent), cutworms and caterpillars (7 per cent), cicadas and other hemipterous insects (5 per cent), ants, bees, and wasps (4.24 per cent), and scorpions (3.67 per cent). Lizards of three species (3.73 per cent), two birds (1.56 per cent), one tiny cottontail rabbit (1.0 per cent), and two wild mice of two different species (2.38 per cent) composed the vertebrate food.

The results of stomach examinations substantiated rather than altered published statements regarding the food of the roadrunner. From published sources, however, came added information as to the number of snakes and lizards consumed by this bird and practically all of the information regarding its bird-eating habits. One lizard, the whip-tailed lizard (*Cnemidophorus*), appears to be taken more often than any other species.

The individual capacity for food in this bird is great, for an average full stomach contains about ten cubic centimeters of food. The collective capacity, however, is small, due to the paucity of individuals. The amount of damage possible (and this must be said also of the potential good) is greatly minimized because there is no concentration of individuals in any one place. A wide variety of food items from small insects to reptiles and mammals is consumed.

Little evidence was obtained that the roadrunner is detrimental to man's interests. The destruction of a few beneficial insects and birds, and of certain lizards usually considered beneficial, can alone be taken as evidence against it. Even if the consumption of a certain proportion of all of the above as food be a fixed habit, the end result is minimized when the facts are taken into consideration that the roadrunner is a bird of the desert regions rather than of the cultivated fields and that the species exists in but small numbers.

A preponderance of evidence favors the bird. The destruction of such unquestioned pests as grasshoppers, cutworms, caterpillars, and wireworms, and of such rodents as mice is to be desired even if the amount of destruction be relatively small. The taking of this sort of food on wild land is evidence that this bird when feeding in cultivated fields is likely to be distinctly beneficial.

Evidently the roadrunner never turns its attention to any sort of cultivated crops as do those birds with granivorous and frugivorous habits. On the contrary, a study of its food habits shows that the roadrunner feeds upon the insect and rodent pests which attack cultivated crops, and furthermore that it destroys hairy caterpillars, a pest not commonly attacked by other birds.

As shown by this investigation, the food habits of the roadrunner in California do not prove the bird to be harmful to any great extent. Instead, it has been clearly shown that the benefits conferred through the destruction of injurious insects and small rodents, though not great, outweigh in value the harm done through the destruction of lizards and birds. In fact, the destruction of a roadrunner can be justified only under exceptional circumstances, and certainly the wholesale destruction of the species because of its supposed habit of destroying the eggs and young of quail is unwarranted. It is to the interest of every citizen of the state to protect carefully this most curious and interesting bird.

Transmitted March 22, 1916.

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PLATE 1

Fig. 1.—Nest of roadrunner situated in tangle of chilicothe and opuntia. Photograph by Donald R. Dickey, taken at Lakeside, San Diego County, California.

Fig. 1

PLATE 2

Fig. 2.—Roadrunner on nest in cactus. Photograph by Donald R. Dickey, taken near San Diego, California.

Fig. 2

PLATE 3

Fig. 3.—Roadrunner carrying a whip-tailed lizard (*Cnemidophorus*). Photograph taken by W. L. Finley near Tucson, Arizona. After Finley and Finley, 1915, by permission.

Fig. 3

PLATE 4

Fig. 4.—Stomach contents of a roadrunner taken at Nestor, San Diego County, January 19, 1913. The stomach contained twenty-four beetles (*Microschatia inaequalis*), one large beetle (*Eleodes* sp.), one beetle (*Amara* sp.), one wireworm, and thirteen Jerusalem crickets (*Stenopelmatus* sp.).

Fig. 5.—Parts of thirty-six cicadas (*Cacama crepitans*) found in the stomach of a roadrunner taken at Otay, San Diego County, May 30, 1912. The stomach also contained one carabid beetle, four short-winged grasshoppers, one robber fly, one stink bug, one carpenter bee, and one small spider.

Fig. 4

Fig. 5

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DESCRIPTION OF *BUFO CANORUS*, A NEW TOAD FROM THE YOSEMITE NATIONAL PARK

BY
CHARLES LEWIS CAMP

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DESCRIPTION OF *BUFO CANORUS*, A NEW TOAD FROM THE YOSEMITE NATIONAL PARK

BY
CHARLES LEWIS CAMP

(Contribution from the Museum of Vertebrate Zoology of the University of California)

Included in the material gathered by the Yosemite Natural History Survey, and now being worked up at the Museum of Vertebrate Zoology under the direction of Dr. Joseph Grinnell, are a number of toads of a species which up to the present time has apparently escaped the attention of naturalists. Comparison with a large series of toads of the *boreas* group at hand shows that the new species possesses characters not included within the limits of that variable assemblage.

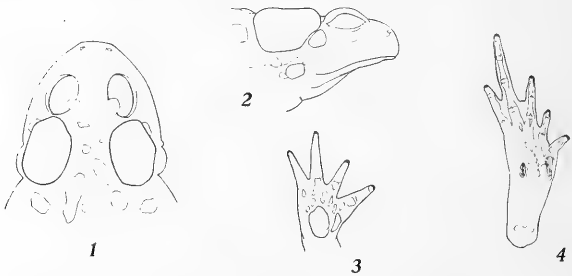
Bufo canorus, new species

Yosemite Park Toad

Type.—Female, adult; no. 5744, Mus. Vert. Zool.; Porcupine Flat, 8100 feet altitude, Yosemite National Park, Mariposa County, California; July 1, 1915; collected by C. L. Camp; orig. no. 2129.

Diagnosis.—A medium sized toad with no head crests; parotoids large, flat, circular, separated by a space usually less than their own diameter and never greater; vertebral streak wanting in most males and represented in other specimens by a thread-like, white line. Color distinctive, and differing greatly in the two sexes; females with irregular, dark blotches, each usually bordered narrowly with white; males speckled with black on a dull greenish background and without distinct dark patches on back.

Material.—Forty-two alcoholic specimens, all but one from within the Yosemite National Park at the following localities: Near Peregoy Meadow, 7000 feet altitude (no. 5742♀); near Mono Meadow, 7300 feet (no. 5747♂); East Fork Indian Cañon, near B. M. 7937 feet (no. 5728♀); vicinity of Porcupine Flat, 8100–8200 feet (nos. 5729♀, 5730♀, 5736♀, 5743♀, 5744♀, 5759♀); vicinity of Ragged Peak, 9700–10,200 feet (nos. 5721–5727, all ♂♂, 5731♀, 5732♀, 5734♀, 5735♀, 5737♂, 5738♂); head of Lyell Cañon, 9700–11,000 feet (nos. 5733♀, 5739♂, 5740♂, 5741♂, 5745♀, 5748♂, 5749–5753, all ♂♂, 5754–5758, all ♀♀, 5760♂); Vogelsang Lake, 10,350 feet (nos. 6035♀, 6044♀). One specimen from Tioga Lake, Mono County, 10,000 feet (no. 5746♀).



Bufo canorus; ♀ type; all × 1

Fig. 1. Top of head; note great width of parotoids and shape of snout.
Fig. 2. Side of head; note extent of parotoids and steep profile of snout.
Fig. 3. Front foot, from below; note small inner metacarpal tubercle.
Fig. 4. Hind foot, from below; note reduced webbing and large outer metatarsal tubercle.

Comparisons.—In profile, lack of head crests, small tympanum, and short legs this toad resembles *Bufo boreas* and its subspecies, but may be distinguished at once from these forms by its smaller size, enormous width of parotoids, slight interval between parotoids, very smooth skin, absence of a broad vertebral stripe, and markedly different color pattern in both sexes. In extent of webbing of hind foot the present species most nearly resembles *B. boreas halophilus,* its near neighbor in the southern Sierra Nevada and the San Joaquin Valley. Specimens of *B. boreas boreas* from Mono County, directly to the east of the range of *canorus,* have the large hind foot characteristic of the more northern subspecies.

MEASUREMENTS IN MILLIMETERS OF TYPE SPECIMEN

Total length	69.1	Hind foot	39.0
Head length	18.9	Spread of hind foot	22.8
Head width	26.0	Length of parotoid	12.2
Hind leg	82.0	Width of parotoid	10.7
Tibia	25.6	Interorbital space	7.2

Color (*in alcohol*).—Adult female, no. 5744, the type: All dorsal and lateral surfaces, including sides of head, rostrum and parotoids, thickly marbled with irregular but clearly defined, dark patches, each surrounded by a brilliant white line; many of the dark patches end abruptly at the mid-line, and do not cross it except in the anal region; ground-color almost white, becoming brownish on the back and parotoids; large tubercles in centers of dark patches tipped with brown: limbs mottled like rest of body; underparts clear white except for a few obscure dark specks; skin between large tubercles very smooth; no trace of speckling or of small dots between the dark blotches. This coloration is typical of all of the females, even the smallest.

Adult male, no. 5747, typical in coloration of all the males in the series: Dorsad and laterad the body and limbs are covered evenly with minute dots of black on a uniform olive-green ground-color; each dark speck surrounded by a narrow white ring; underparts grayish white with scattered dots of a larger size than those on the back. The skin is exceptionally smooth, and the larger tubercles and even the parotoids are scarcely discernible.

Remarks.—This toad is extraordinary in its pronounced sexual dimorphism. The striking black and white pattern of the female is entirely lost in most of the males, but a few of the latter show, by traces of blotching about the head and legs, that their speckled pattern is the result of a breaking up into smaller dots of the larger blotches of the female. In coloration the female of *Bufo canorus* bears some resemblance to the brighter patterns of *Bufo boreas;* the male phase has some counterpart in the latter species in the case of an occasional male of *boreas,* which assumes a dull green color and smooth skin during the breeding season. In the series of *canorus* the glandular development in the males is much less than in the females; in most of the males even the parotoids are not well developed, though their characteristic circular outline can still be traced.

The web of the hind foot is small; the spread of the hind foot is about 30 per cent of the total body-length, as in *Bufo boreas halophilus.* The sole is free from the asperities developed by toads of more arid regions, and both inner and outer metatarsal tubercles are distinct and nearly equal in size. The inner metacarpal tubercle is less than half the size of the outer.

Distribution and habitat.—The limits of the range of *Bufo canorus* north and south of the Yosemite Park are unknown. The species seems to be absent from the high altitudes of Placer County and from the Sierras south of the Kings River, where its place is taken by *Bufo boreas halophilus,* which there goes to a high elevation. It is the only toad found in the higher parts of the Yosemite National Park, where it inhabits wet meadows and lake shores from about 7000 feet altitude on Bridal Veil Creek among lodge-pole pines to 11,000 feet on the headwaters of the Lyell Fork of the Tuolumne River, near the upper limit of the white bark pines. It does not seem to live at the lower altitude of the Yosemite Valley proper, where the larger species, *Bufo boreas halophilus,* is found.

The specific name selected, *canorus,* refers to the long-sustained, melodious trill uttered by this toad. This diurnal singing accompanies the breeding activities, which take place as soon as the snow melts from the Sierran meadows, June 1 to July 15. Many of the females captured at this time contained mature eggs.

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THE SUBSPECIES OF *SCELOPOROUS OCCIDENTALIS*

WITH DESCRIPTION OF A NEW FORM FROM THE SIERRA NEVADA AND SYSTEMATIC NOTES ON OTHER CALIFORNIA LIZARDS

BY

CHARLES LEWIS CAMP

UNIVERSITY OF CALIFORNIA PRESS
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CONTENTS

Notes on Sceloporus occidentalis

In a systematic treatment of the lizards of the genus *Sceloporus* occurring in the Pacific district, Van Denburgh (1897, pp. 73–74, 77–84) calls the two closely related forms, *occidentalis* and *bi-seriatus*, distinct species, and separates them by the characters of size and of the degree of confluence of the throat patches in males. An examination of the series of about 900 specimens representing these two forms, contained in the Museum of Vertebrate Zoology, has revealed the existence of a definite intergradation between them through an extensive area in California.

In males from points within the range of typical *occidentalis,* in the Sacramento Valley and in Humboldt, Marin, Napa and Alameda counties, about 72 per cent have the throat patches joined as in all male *bi-seriatus.* The other 28 per cent of the males is what we should have to rely on for the separation of these races if we held to this character alone. Our series of *occidentalis* from eastern Mendocino County averages about as large in size as a series of small *bi-seriatus* from Los Angeles County. It therefore becomes desirable to seek out some additional character as a criterion for the separation of these two forms, if they are, indeed, to be considered worthy of systematic notice at all.

Nearly every male *occidentalis* I have examined can be distinguished from *bi-seriatus* by the greater amount of light color on the underparts, particularly on the lower surface of the hind limbs and on the chest and between the belly patches. A single specimen of *occidentalis* from Monterey and ten or so of a large series from the coast of northern California have the parts mentioned dark greenish or slaty in color. A male from Bakersfield, and another from Little Rock Creek, Los Angeles County, each has an unspotted light stripe down the center of the belly and cannot be distinguished from average *occidentalis,* although obtained well within the range of *bi-seriatus.* But these are exceptions in a very large series which shows the general duskier color of the subspecies *bi-seriatus.*

The most interesting thing about this character of the color of the underparts is the distribution of the intergrades, which occupy a zone running from the coast near San Luis Obispo northeast to western Merced County, thence across the San Joaquin Valley to Coulterville, Mariposa County, then northward over the Sierras to eastern Modoc County. The range of *occidentalis* northwest of this zone contrasts in its greater humidity with the range of *bi-seriatus* to the southeast of it.

In the intergrades the white chest, mid-ventral line and hind limbs are flecked by numerous dark scales, either widely separated (as in *occidentalis*), or joined into a general dusky suffusion as in *bi-seriatus.* The body-length of individuals increases noticeably as one goes south through the Sacramento and San Joaquin valleys from Yolo and Solano counties into Fresno and Kern counties. This increase in size and change in coloration of the underparts is most abrupt in the narrow district lying between the Merced River and Raymond, Madera County. Adult males from San Emigdio and Walker Basin, in Kern County, are from 75 to 90 millimeters in length of body (averaging 85 millimeters). The largest males of *occidentalis* from various localities in the Sacramento Valley and in Modoc and Humboldt counties range from 62 to 80 millimeters and average about 71. Those from such intermediate points as eastern Merced County, and Raymond, Madera County, are from 71 to 80 millimeters long and average about 75.

A key that will apply invariably for all individuals of both sexes of the following three subspecies cannot be formulated. Females without blue throat patches can be referred to *S. o. occidentalis*, those with a single throat patch to *S. o. bi-seriatus* (see Van Denburgh, 1897, p. 73), but beyond this the identification of females is best not attempted. Males (told at once by the enlarged post-anal plates) can be distinguished by the following key:

A. Belly-patches separate from throat patches and divided by either a lighter or darker band.

b. Chest, mid-ventral line and lower surface of hind limb very light in color or speckled with darker scales; blue throat patches in young males sometimes divided by light or dark scales; body length of adults 62–80 millimeters.

Sceloporus occidentalis occidentalis Baird and Girard.

b′. Chest, mid-ventral line and lower surface of hind limb grey or black in color; blue throat patch never divided; body length of adults 75–90 millimeters.

Sceloporus occidentalis bi-seriatus Hallowell.

A′. Belly-patches confluent with throat patch and not divided by a lighter or darker band; ventral color deep blue throughout; little or no dusky color on chest.

Sceloporus occidentalis taylori Camp.

It is desired here to describe a very distinct new subspecies of *Sceloporus occidentalis* occurring about the headwaters of the Merced River in the Yosemite National Park and perhaps farther south in the Sierra Nevada. Specimens of this brilliantly colored lizard were collected by various members of the field party from the Museum of Vertebrate Zoology, which participated in the Natural History Survey of the Yosemite region during 1914–1915.

Sceloporus occidentalis taylori, new subspecies

Tenaya Blue-bellied Lizard

Type.—Male, adult; no. 5947, Mus. Vert. Zool.; half way between Merced Lake and Sunrise Trail (Echo Creek basin), altitude 7500 feet, Yosemite National Park, California; August 25, 1915; collected by Walter P. Taylor; orig. no. 7361.

Diagnosis.—Size, equalling the largest *Sceloporus occidentalis bi-seriatus;* underparts, in the male, blue throughout; belly-patches not separated by a lighter or darker mid-ventral line; throat evenly colored, light blue to snout and lips, and lighter in tint than general ventral color; blue of belly not separated from throat patch by a lighter or darker area across gular region (young specimens excepted). Female more richly colored below than in *bi-seriatus;* lighter than male; belly-patches separated by a faintly lighter area; chest lighter than belly; one extensive throat patch as in male; blue not always extending to beneath hind limb.

Color (in alcohol).—Belly alizarine blue (of Ridgway, 1912), in darkest males, to clear cadet blue in the lightest females; throat diva blue to light cadet blue; chest only slightly dusky in the darkest specimens; males with hind limbs beneath and anterior border of anus, greenish blue, nearly as dark as belly. Back very dark as in darkest *bi-seriatus;* sides and some scales on back greenish; lighter and darker crescentic markings on back obscure, most so in males. Females with four series of small light spots down back.

Material.—Fourteen males and ten females from the higher elevations of the Yosemite National Park at the following localities: Washburn Lake, 7640–7700 feet; near Merced Lake, 7500 feet; Echo Creek basin, Merced River, 7300–7500 feet; lower McClure Fork, Merced River, 7800 feet; Lake Tenaya, 8100 feet; and Glen Aulin, Tuolumne River, 7300 feet.

Remarks.—A number of individuals at hand in a large series of *S. o. bi-seriatus* from the southern Sierras in Kern and Tulare counties and farther north are, of all our specimens, the closest in size and ventral coloration to *taylori;* they are, however, of greenish and more dusky shades of blue beneath than the new form, and their status must be held questionable pending the acquisition of material from the headwaters of the Kings and San Joaquin rivers. A male specimen, one of two, from the Yosemite Valley, 4000 feet altitude, seems to be intermediate in size and color between this form and a series of *S. o. occidentalis* at hand from western Mariposa County. In the Yosemite Park this subspecies lives on rocky, sunlit slopes in the heavily glaciated region in the upper Merced basin, about Lake Tenaya, and in the head of the Tuolumne Cañon, at altitudes between 7300 and 8200 feet.

Notes on Sceloporus graciosus

The representatives of *Sceloporus graciosus* isolated upon several of the mountain ranges of southern California south of Mount Pinos, Ventura County, appear to constitute a locally differentiated race. It is here proposed to reinstate the name *vandenburgianus* (Cope, 1896, p. 834) for this subspecies, the type locality of which is the "Summit of the Coast Range, San Diego County, Calif."—probably in the yellow pine belt on the Laguna Mountains, San Diego County.

Sceloporus graciosus vandenburgianus Cope

Van Denburgh Lizard

Diagnosis.—Like *S. g. graciosus*, but adult males with blue belly-patches united across mid-line, or else separated by a very narrow interval only; belly-patches confluent with throat patch; undersurface of hind limb and tail dark blue; the lighter, broad, mid-ventral line and chest-patch of *graciosus*, indefinite or absent; blue of underparts sometimes nearly black, usually darker than in *graciosus*. Females more dusky in color beneath than females of *graciosus*.

Material.—Ninety-two specimens of *Sceloporus graciosus vandenburgianus* from the following localities in southern California: San Diego County: a single adult male from the Cuyamaca Mountains, 6000 feet altitude; Riverside County: Santa Rosa Peak, 7500 feet, Santa Rosa Mountains, 7; San Jacinto Mountains, 21, from Thomas Mountain, Strawberry Valley (6000 feet), Tahquitz Peak (8000 feet), near Round Valley (8500 feet), vicinity of Fuller's Mill (5850–7000 feet), and vicinity of Schain's Ranch (5200–5500 feet); San Bernardino Mountains, San Bernardino County: 32, from Fish Creek (6500–6700 feet), South Fork of Santa Ana River (6200 feet), Santa Ana River (5500 feet), and Clark Hill (6000 feet); San Gabriel Mountains, Los Angeles County: 31, from vicinity of Mount Wilson (4150–5800 feet), Mount Lowe (4000 feet), and vicinity of Pine Flats (5500–5800 feet).

Of *Sceloporus graciosus graciosus* there are in the Museum of Vertebrate Zoology 282 specimens, from Mount Pinos, Ventura County, the southern Sierra Nevada, central and northern California, Humboldt County, Nevada, and Wallula, Washington.

Remarks.—The series of sixty-three *vandenburgianus* from the San Gabriel and San Bernardino mountains is nearer *graciosus* in coloration than specimens from farther southeast. Several large males (nos. 776, 777, 781, 783, 790) from the San Bernardino Mountains cannot be told from typical *vandenburgianus,* and some others are lighter ventrally than any males from south of San Gorgonio Pass. The series from the San Gabriel Mountains includes the lightest-colored males of the subspecies, and they are in this respect very good intermediates, despite their isolated station, between the small, light-colored *graciosus* of Mount Pinos and the large, dark blue specimens of *vandenburgianus* from the headwaters of the Santa Ana River, and farther south.

Cases of this sort of distribution bear on the question whether intermediates between two adjacent forms may be hybrids. In the present instance the low passes of Soledad, Cajon and San Gorgonio separate the range of the intermediates into a chain of mountain-top "islands" and seem to preclude the possibility of hybridization at the present time.

The darker ventral color and larger size of the southern race of this species is interestingly paralleled in *Sceloporus occidentalis, Gerrhonotus scincicauda, Cnemidophorus tigris,* and *Eumeces skiltonianus,* in which species the southern and desert forms are bluer or blacker beneath and duskier above.

NOTES ON UTA STANSBURIANA

Richardson (1915, pp. 412–418) separates *Uta stansburiana* into the following three subspecies: *U. s. stansburiana,* characterized by its greater number (average 103.4) of dorsal rows of weakly carinated scales and its few femoral pores (average 13 +); *U. s. elegans,* with from 78 to 103 (average 86) dorsal rows of more heavily keeled scales, an average of 14 + femoral pores and a greater tail length; and *U. s. hesperis,* with from 87 to 117 dorsal rows of heavily carinated scales, and an average of 14 + femoral pores. He extends the range of the typical subspecies, *stansburiana,* into California on the basis of two specimens from Round Valley and Lone Pine, Inyo County. Counts of dorsal scale rows of some additional specimens of this species in the Museum of Vertebrate Zoology from Inyo County seem to indicate that western Inyo County is the locality in California where intergradation between *stansburiana* and *elegans* takes place. Table I shows how the number of scale rows increases as one goes north through Owens Valley.

I. Table Showing Numbers of Dorsal Transverse Scale Rows in Specimens of Uta s. stansburiana and U. s. elegans

Mus. No.	Locality	Dorsal scale rows	Remarks
3105	Mohave, Kern Co.	83	*elegans*
3644	Keeler, Inyo Co.	87	*elegans*
3104	Carroll Creek, Inyo Co.	97	intergrade
	Average of two specimens, Independence, Inyo Co.	99	intergrade
	Average of five specimens, Kearsarge Pass, at 6000 feet, Inyo Co.	99	intergrade
6072	Laws, Inyo Co.	93	intergrade
	Average of three specimens, Benton, Mono Co.	102	*stansburiana*
	Average of fifty-five specimens,* Utah, Nevada, Idaho, and Oregon	103	*stansburiana*

* According to Richardson (1915, p. 418).

Counts of scale rows in twenty specimens of *stansburiana* picked at random from series collected at a number of points in the San Joaquin Valley and in San Luis Obispo County indicate that the subspecies occurring in this region is *hesperis*, rather than *elegans*, as Richardson (1915, p. 414) has indicated. The intergradation between *hesperis* and *elegans* seems to occur at such places as northern Los Angeles County, Walker, Cajon and San Gorgonio passes, and eastern San Diego County. This is shown in table II.

II. Table Showing Number of Dorsal Transverse Scale Rows in Specimens of Uta s. elegans and U. s. hesperis

Mus. No.	Locality	Dorsal scale rows	Remarks
3099	Kelso Valley, Kern Co.	86	*elegans*
3102	Fay Creek, near Weldon, Kern Co.	95	intergrade
3075	West side Walker Pass, Kern Co.	93	intergrade
3084	West side Walker Pass, Kern Co.	92	intergrade
	Average of twenty specimens from San Joaquin Valley and San Luis Obispo Co.	100	*hesperis*
885	Gorman, Los Angeles Co.	93	intergrade
4175	Pallett, Los Angeles Co.	94	intergrade
603	Cajon Wash, San Bernardino Co.	97	intergrade
605	Cajon Wash, San Bernardino Co.	97	intergrade

Mus. No.	Locality	Dorsal scale rows	Remarks
5396	Victorville, San Bernardino Co.	77	*elegans*
5397	Victorville, San Bernardino Co.	79	*elegans*
3580	Banning, Riverside Co.	91	intergrade
90	Snow Creek, Riverside Co.	91	intergrade
252	Palm Cañon, Riverside Co.	97	intergrade
491	Carrizo Creek, San Diego Co.	88	*elegans*
1043	Warner Pass, San Diego Co.	86	*elegans*
1585	Julian, San Diego Co.	90	intergrade
986	Mountain Spring, San Diego Co.	91	intergrade
3587	Imperial Valley, Imperial Co.	77	*elegans*

Notes on Callisaurus and Crotaphytus

In his description of *Callisaurus ventralis myurus,* Richardson (1915, p. 410) gives the range of this new form, doubtfully, as extending as far south as Owens Valley, in California. The darkest of ten specimens in the Museum of Vertebrate Zoology from Keeler, Inyo County, are not different in color from individuals collected at Barstow on the Mojave desert in San Bernardino County. The average number of femoral pores in this series is 14.3 and the average ratio of tail to body length .737, thus agreeing with Richardson's determination of .727 for *C. v. ventralis* from the Colorado desert, and differing from the average of .807 given for *myurus* from Pyramid Lake, Nevada. Since *Callisaurus* does not seem to range north through Owens Valley into Mono County, specimens from the former region are not in what could be considered an area of intergradation between *ventralis* and *myurus.*

It should be noted that the provisional assignment of the Death Valley *Callisaurus* to *myurus* on the basis of Merriam's notes is a mistake, since the *Callisaurus* of which Merriam speaks pertained to Desert Valley, east of the Pahroc Mountains, Nevada (Stejneger, 1893, p. 172).

It is interesting to add that Richardson's discovery of a decrease in tail length and number of femoral pores in the more northern forms of widely ranging species of lizards can be confirmed upon a study of *Crotaphytus collaris baileyi* and *Crotaphytus wislizenii.* Ten examples of the former species in the Museum of Vertebrate Zoology from Humboldt County, Nevada, have an average ratio of body length to tail length of .549 (minimum .521) and an average of 16 + (maximum 19) femoral pores. Eight specimens of *baileyi* from southern California have an average ratio of body length to tail length of .476

(maximum .491) and femoral pores averaging 20 + on each thigh (minimum 18). Three specimens from the Inyo Mountains and the Kern River, five miles above Kernville, are .450, .517, and .530, in body-tail ratio, and their femoral pores average 17; hence these specimens are intermediate.

Crotaphytus wislizenii from Humboldt County, Nevada, has 18 + femoral pores on the average, and a body-tail ratio of .504 (average of four specimens, agreeing closely with figures derived from Richardson's (1915, p. 407) measurements, of .496 for males and .510 for females of this species from Pyramid Lake, Nevada. The same species from southeastern California has a body-tail ratio of .463 (average of five specimens) and an average of 23.7 femoral pores. The minimum body-tail ratio in the Nevada specimens is .500, and the maximum in the southern California specimens measured is .492. The maximum number of femoral pores in the northern specimens is 19, the minimum in the southern examples 20.

Notes on Cnemidophorus tigris

Because of the practical impossibility of separating *Cnemidophorus tigris* and *Cnemidophorus stejnegeri* at certain points on the desert divides and farther east in southern California, the writer believes that the forms in question had best be placed together as subspecies. Our series of *Cnemidophorus* (excepting *beldingi*) includes about 430 specimens from California and northern Nevada. Two critical localities, Walker Pass, Kern County, and San Gorgonio Pass, Riverside County, are represented by large numbers of specimens. A study of these shows that there is both an intergradation of *Cnemidophorus tigris* **mundus** (a new name here proposed for *C. tigris undulatus* preoccupied by the *C. undulatus* of Wiegmann, 1834, pt. 1, pp. 27–28) with *tigris* in the Walker Pass region, as indicated by Stejneger (1893, pp. 200–201), and of *stejnegeri* with *tigris* in Antelope Valley, Los Angeles County, around the north base of the San Jacinto Mountains (cf. Atsatt, 1913, pp. 39–40), and in eastern San Diego County.

The Walker Pass intergrades show a puzzling similarity to *stejnegeri* in the heavy spotting of the throat and, as a rule, in the lack of smaller central gular scales. Since none of the specimens from the Walker Pass region have as large gular scales as some *stejnegeri*, and in view of their geographic position linking two closely related subspecies, it seems better to consider them as above, and to suggest that the color characters of *stejnegeri*, like some factors of its environment, are intermediate between those of *tigris* and of *mundus*.

The difficulty of separating *tigris* and *stejnegeri* comes from the fact that *stejnegeri* on the desert borders of its range gradually takes on the dusky suffusion of *tigris*, and that many examples of *tigris*, even from the interior desert regions, have fully as large central gular scales as the majority of *stejnegeri*.

Intergrades between *stejnegeri* and *mundus* have not been recognized in our material. Specimens from Fairmont, on the Mohave Desert, Los Angeles County, and from Matilija, Ventura County, are *stejnegeri;* and others from San Emigdio Plain, Kern County, and Santa Margarita, San Luis Obispo County, have the central gular scales smaller and are placed with *mundus*. We have no specimens from the interlying area.

Variations of Eumeces skiltonianus

Van Denburgh (1896, p. 350) has described a large, red-headed skink from the Yosemite Valley as *Eumeces gilberti*. In referring to this species later (1897, p. 149) the same writer makes the statement that "Were it not for the different position of the light stripes of the young and the fact that this form seemingly does not occur in most parts of the range of *E. skiltonianus*, *Eumeces gilberti* might be regarded as a color phase of the Western Skink." Cope (1900, pp. 640–644), describing two new "varieties" (*amblygrammus* and *brevipes*) of *E. skiltonianus* from California, apparently ignores the name *gilberti*, but mentions a "largest" specimen of *E. s. skiltonianus* from El Dorado, California, in which the "upper parts are entirely uniform olive." The question still remains, therefore, whether "*gilberti*" may not be a variation of *E. skiltonianus* due to age, rather than a distinct species.

The Museum of Vertebrate Zoology has a series of eighty-one *Eumeces* from the various parts of California, including thirty specimens of the form "*gilberti*" from near the type locality of the latter, in Stanislaus, Merced, Mariposa, and Madera counties. There are also in this series ten large specimens of *Eumeces*, not to be distinguished from "*gilberti*," from Amador, San Joaquin, Kern, San Bernardino and San Diego counties. All of our skinks from the coast districts north of San Diego County are under seventy-five millimeters in body length and have distinct stripes. Females of "*gilberti*" are smaller than the large red-headed males and all but one (this specimen from the Kern River, twelve miles below Bodfish) retain some traces of the primary longitudinal striping. Of our seventeen adult "*gilberti*" from near the type locality only four are females and these are the smallest of the lot (maximum body length of females, ninety-two millimeters; of males, 107). In the coast districts the males and females are of equal numbers and of the same size. Eight young specimens from near the type locality of "*gilberti*" show as much variation in the position of the middle pair of dorsal white lines as does *skiltonianus* from elsewhere. But a single individual from Yosemite Valley has the white stripes separated by only the two median scale rows. Others have from one-fourth to one-half of the second rows dark, as do specimens at hand from other parts of California.

The upshot of the matter, then, is that all the California *Eumeces* are to be considered as a single species, *skiltonianus*, which exhibits age and sex variations almost identical with those shown by the eastern skink, *E. quinquelineatus*. According to Cope (1900, pp. 636–637) *quinquelineatus* "attains a much larger size in the more southern states than in the northern, there going through all the stages of coloration, and that the farther north the more is this restricted to the primary pattern." A parallel situation seems to obtain in *skiltonianus*.

Transmitted October 11, 1916.

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OSTEOLOGICAL RELATIONSHIPS OF THREE SPECIES OF BEAVERS

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(Contribution from the Museum of Vertebrate Zoology of the University of California)

CONTENTS

INTRODUCTION

Scope

The following paper contains the results of a detailed comparison of certain extra-cranial parts of the skeletons of *Castor subauratus, Castor canadensis,* and *Castor fiber.* This study was originally undertaken with the first two species, to determine whether the osteological data which could thus be obtained would confirm the systematic status of the forms as indicated by the study of the skins and skulls alone (see Taylor, 1916). After these observations had been recorded, a single skeleton of *Castor fiber* was obtained and the condition of each point of variance between *canadensis* and *subauratus* was noted. These results, also, have been incorporated.

The specific characters of *canadensis,* as regards the skeletal parts studied, have been taken from the three subspecies *Castor canadensis belugae, C. c. leucodonta,* and *C. c. phaeus.* In addition to the comparisons given in the text of the present paper, a tabulated statement is added, giving the most obvious differences to be noted in the bones of the limbs and of the pectoral and pelvic girdles.

It should be remembered that the comparisons, throughout, are based upon a small series of skeletons, so that the examination of further material may prove that some of the characters given are not diagnostic. So far as it has been found feasible, all characters which appear to be of average persistence, but which fail in one or two instances in the series studied, have been noted as "tendencies."

Material

The major portion of the observations herein contained were made from the following specimens now in the California Museum of Vertebrate Zoology.

	No.	Sex	Locality
Castor canadensis phaeus	210	♂	Hasselborg Lake, Admiralty Island, Alaska
Castor canadensis belugae	4347	♂	Snug Harbor, Alaska Peninsula, Alaska
Castor canadensis leucodonta	12101	♂	Alberni, Vancouver Island, B. C.
Castor subauratus	8869	♂	San Joaquin River, near Grayson, Stanislaus Co., California
Castor subauratus	8987	♀	San Joaquin River, near Grayson, Stanislaus Co., California

	No.	Sex	Locality
Castor subauratus	12654	♀	San Joaquin River, near Grayson, Stanislaus Co., California
Castor subauratus	12668	♂	San Joaquin River, near Grayson, Stanislaus Co., California
Castor subauratus	16385	♂	San Joaquin River, near Grayson, Stanislaus Co., California
Castor fiber	19229	?	Elbe River, near Wittenberg, Germany

There will also be found occasional references to other skeletons in the Museum which as yet have not been prepared for study. These are:

	No.	Sex	Locality
Castor canadensis leucodonta	12107	♀	Alberni, Vancouver Island, B. C.
Castor subauratus	8988	♀	San Joaquin River, near Grayson, Stanislaus Co., California
Castor subauratus	16382	♀	San Joaquin River, near Grayson, Stanislaus Co., California
Castor subauratus	16383	♂	San Joaquin River, near Grayson, Stanislaus Co., California
Castor subauratus	16384	♂	San Joaquin River, near Grayson, Stanislaus Co., California

It has been impossible up to the present time to obtain a skeleton of *Castor canadensis frondator,* which form is found in parts of the southwestern United States and barely enters California along the Colorado River.

As far as can be determined from the skeletons, with two exceptions, there is but little difference in age among the specimens of *subauratus;* no. 12654 is much the oldest, and no. 16384 is a juvenile. Among the four representatives of the subspecies of *canadensis* the specimen of *phaeus* appears to be slightly older than the other three.

Acknowledgments

It is proper to make acknowledgment here of many suggestions kindly proffered by Professor William E. Ritter. The writer would also extend thanks for various suggestions to Professors John C. Merriam, Charles A. Kofoid, and J. Frank Daniel, as well as to Doctors Joseph Grinnell and Walter P. Taylor, of the staff of the California Museum of Vertebrate Zoology.

COMPARISONS

Cervical Vertebrae

In all the cervical vertebrae there is a tendency for the laminae and the pedicles to be heavier in *Castor fiber* and *Castor subauratus* than in *Castor canadensis belugae, C. c. leucodonta,* or *C. c. phaeus.* The neural canal appears to be more constant in shape throughout the series of *subauratus* and in *fiber* than in the three subspecies of *canadensis.* There is a tendency for the articulating face of the post-

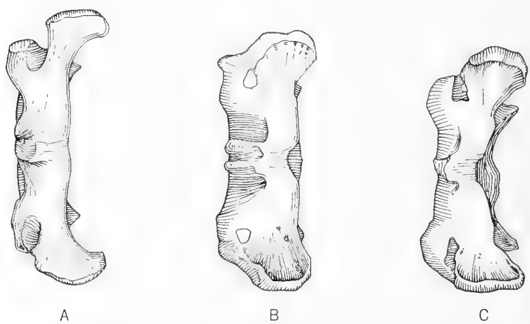
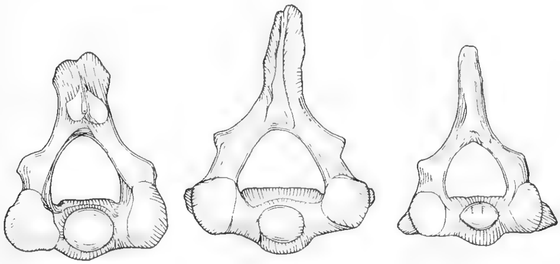


Fig. A.—Dorsal view of atlas of *Castor fiber,* no. 19229. × 1.
Fig. B.—Dorsal view of atlas of *Castor subauratus,* no. 12654. × 1.
Fig. C.—Dorsal view of atlas of *Castor canadensis phaeus,* no. 210. × 1.

zygapophysis of *subauratus* and *fiber* to be more convex and to face laterad to a greater degree than it does in the subspecies of *canadensis.*

The average anteroposterior width of the most dorsal portion of the atlas is greater in *subauratus* and *fiber,* the average for the three subspecies of *canadensis* being 7.8 mm., for *subauratus* 9.8 mm., and for *fiber* 8.9 mm. (see text-figs. A, B, C). In the three forms of *canadensis* the transverse processes of the atlas are thinner and constitute a greater proportion of the entire transverse width than the same processes of *subauratus.* The odontoid process of the axis is most highly developed both in diameter and in length in *phaeus; subauratus* and *fiber* are next in size in this particular, and *belugae* and *leucodonta* are both smaller (see text-figs. D, E, F). The width of the anterior articulating face, at the base of the odontoid process, shows a very marked tendency to be greater in *subauratus* and *fiber* than in the three subspecies of *canadensis* (see text-figs. D, E, F); the average width for the last three forms is 21.8 mm., for *subauratus* 26.1 mm., and for *fiber* 25.7 mm. The neural canal in the axis is

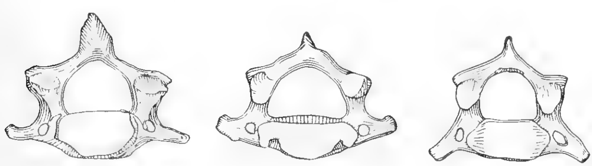


D E F

Fig. D.—Cephalic view of axis of *Castor fiber*, no. 19229. × 1.
Fig. E.—Cephalic view of axis of *Castor subauratus*, no. 12654. × 1.
Fig. F.—Cephalic view of axis of *Castor canadensis leucodonta*, no. 12101. × 1.

larger in *subauratus* than in the three subspecies of *canadensis*, the canal in *fiber* being intermediate in size (see text-figs. D, E, F).

The neural canal in the third cervical vertebra of *subauratus* is nearly semicircular in shape, while in *fiber* and the three subspecies



G H I

Fig. G.—Cephalic view of third cervical vertebra of *Castor fiber*, no. 19229. × 1.
Fig. H.—Cephalic view of third vertebra of *Castor subauratus*, no. 8987. × 1.
Fig. I.—Cephalic view of third cervical vertebra of *Castor canadensis leucodonta*, no. 12101. × 1.

of *canadensis* the laminae and pedicles form a segment of a circle which is greater than a semicircle (text-figs. G, H, I). The vertebrarterial canal of *subauratus* in the third cervical vertebra is almost circular in shape, while in the three subspecies of *canadensis* the canal tends to be elliptical, with the major axis extending transversely (text-figs. G, H, I). There appears to be a tendency in *belugae* and *phaeus* for the vertebrarterial canals to persist throughout the entire seven cervical vertebrae; in *leucodonta* they end with the sixth; in *subauratus* there are two foramina, as a rule, in the sixth cervical vertebra, while the seventh bears one in the right transverse process only; and in *fiber*, in the one specimen observed, there was one foramen in the left process of the seventh thoracic vertebra. From this it will be seen that *leucodonta* alone accords with the specimens of *canadensis* described by Morgan (1868, p. 51) in having foramina throughout six of the series only.

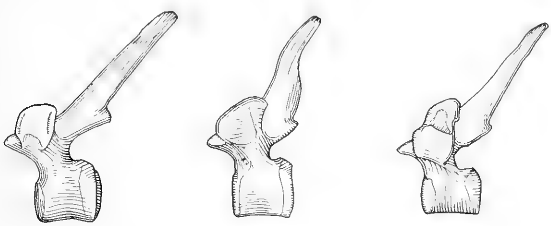
Number of differences noted between *Castor subauratus* and *Castor canadensis*, thirteen. *Fiber* conforms with *subauratus* in nine of these, and with *canadensis* in one; three remaining unassigned.

Thoracic and Lumbar Vertebrae

Castor fiber and the three subspecies of *Castor canadensis* follow the usual rule among rodents and the recorded descriptions of beavers in having nineteen trunk vertebrae (Owen, 1866, pp. 364, 365; Flower, 1876, p. 50; Morgan, 1868, p. 51; Reynolds, 1897, p. 19). With the exception of one specimen, *leucodonta*, no. 12101, they consist of fourteen thoracic and five lumbar vertebrae (Morgan, 1868, p. 19); the individual designated, however, has thirteen thoracic and six lumbar vertebrae, which, according to Owen (1866, p. 365), is generally the case among rodents, and holds with but few exceptions. It is to be noted, however, that a specimen of *leucodonta* (no. 12107) has fourteen thoracic and five lumbar vertebrae, so the possession of thirteen thoracic vertebrae cannot be used as a character of *leucodonta*.

In the series of *subauratus*, without an exception, the number of trunk vertebrae is twenty. In the nine skeletons of this species at hand, there are four with fifteen thoracic and five lumbar vertebrae; four with fourteen and six; and one (no. 16382) with fourteen well-developed ribs articulating on the fourteen thoracic vertebrae, and a rudimentary rib on the right side of the first lumbar vertebra. It may be worthy of note, also, that of the five males three have fifteen thoracic vertebrae, the exceptions being nos. 16383 and 16385; and among the four females three have fourteen thoracic vertebrae, one of these having the variation noted above (no. 16382), and no. 8988 with fifteen thoracic vertebrae. This may show that there is a tendency toward sexual variation in *subauratus* in this regard. The proof of this tendency would require for demonstration a large series of *subauratus.*

Beside the differences recorded above, there are others which are seen when the thoracic and lumbar vertebrae are taken as separate groups. There is a marked tendency for *fiber* and the three subspecies of *canadensis* to have larger centra in all three dimensions, in the thoracic vertebrae, than has *subauratus* (text-figs. J, K, L, and pl. 5). This character is accompanied in the first thoracic vertebra by a broader neural canal in *subauratus* and *fiber* than in *canadensis* (pl. 5, figs. 1, 2, 3, 4); although the height of the canal is also greatest in *subauratus,* in *fiber* it is similar to that in *canadensis.* In the verte-



J K L

Fig. J.—Lateral view of fourth thoracic vertebra of *Castor fiber,* no. 19229. × 1.

Fig. K.—Lateral view of fourth thoracic vertebra of *Castor subauratus,* no. 16385. × 1.

Fig. L.—Lateral view of fourth thoracic vertebra of *Castor canadensis belugae,* no. 4347. × 1.

brae which follow, however, there is a marked tendency for *phaeus* to have the largest neural canal (pl. 5, figs. 5, 6, 7, 8). In the eighth thoracic vertebra and the thoracic vertebrae which follow, *phaeus* possesses the largest neural canal, both in transverse and dorso-ventral measurements.

The ratio of the width to the height of the eighth thoracic vertebra averages 83.3 per cent in *subauratus,* 84.5 per cent in *fiber,* and 69.7 per cent in *canadensis.* On the thirteenth vertebra these ratios are: *subauratus,* 66.4 per cent; *fiber,* 100.9 per cent; and *canadensis,* 58.6 per cent.

If we compare the height of the thoracic vertebrae from the base of the neural spine to the most ventral portion of the centrum (cf.

Hue, 1907, pl. 17, "*S S′*, hauteur totale du corps de la vertèbre" (it should be noted that Hue's "corps" does not correspond to the BNA term *corpus*), we find that anteriorly in the series the greater measurement is found in *subauratus* and *fiber* (pl. 5, figs. 1, 2, 3, 4); on the first thoracic vertebra: *subauratus* 16.1 mm., *fiber* 15.2 mm., and *canadensis* 14.3 mm. On the fourteenth thoracic vertebra, which has a larger measurement in all three species, the opposite order holds: *canadensis* 21.0 mm., *subauratus* 20.7 mm., and *fiber* 20.5 mm. Correlated with this is the extreme width of the thoracic vertebrae; in the earlier members of the series the greatest average measurement is found in *fiber*, next in width is *subauratus*, and the narrowest is *canadensis*. Later in the series, however, *fiber*, *canadensis*, *subauratus*, is the order (pl. 5).

There are certain structural features which are differently located or differ in extent in the three species. The neural spines of the first ten thoracic vertebrae in *subauratus* and *fiber* are styliform, while the remainder are flattened from the sides; in the three subspecies of *canadensis* only the first nine are styliform, the remainder being laterally compressed. The thoracic vertebrae posterior to the eleventh or twelfth, in *subauratus*, have an articulating surface between the anapophysis and the prezygapophysis; on the other hand, there are no articulations between these processes in *canadensis* or *fiber*.

On the dorsal surface of the transverse process of the first thoracic vertebra of all three species of beaver so far as has been observed, there is a small tuberculum at the place where the anapophysis joins the metapophysis. In *belugae*, on the second thoracic vertebra and on several posterior to it, this process is ear-shaped (text-fig. L); in *leucodonta* this ear-shape appears first on the third thoracic vertebra; in *phaeus* on the fourth; in *subauratus* and *fiber* this ear-shape does not occur on any of the first six (text-figs. J, K), but is seen first on the seventh thoracic vertebra. It is noteworthy that these differences show merely a tendency in the three subspecies of *canadensis* for this ear-shaped process to occur farther anteriorly in the series of thoracic vertebrae. More material would be necessary to prove the exact location of the first appearance of this form of the joined processes in each subspecies of *canadensis*.

In *subauratus* the neural spines of the thoracic vertebrae, with the exception of the first, are heavier than in the three subspecies of *canadensis* (text-figs. K, L).

There is a tendency for *subauratus* and *fiber* to have ten clearly defined pairs of transverse processes, and for the three subspecies of *canadensis* to have only nine. One specimen of the latter possesses only eight.

The neural spine of the first thoracic vertebra is shorter and less inclined from the vertical in *subauratus* than in *fiber* or the three subspecies of *canadensis* (pl. 5, figs. 1, 2, 3, 4). On the first thoracic vertebra of *fiber*, *subauratus*, and *phaeus* there is a small notch on the posterior margin of the vertebral arch at the base of the neural spine, which does not appear in the other two forms. It is possible to distinguish *subauratus* from *phaeus* or *fiber* by this character, as the notch in *phaeus* and *fiber* allows the neural spines of the first two thoracic vertebrae to come very close together along the median plane, while in *subauratus* the neural spines are held apart.

There is a tendency for the neural spine of the fourth thoracic vertebra to be longer in *subauratus* and *fiber* than in the three subspecies of *canadensis*.

In the three forms of *canadensis* the ear-shaped processes on the eighth thoracic vertebra extend laterally to a greater degree than the transverse processes, while in *subauratus* and *fiber* the opposite is true. In *subauratus*, *leucodonta*, and *belugae*, on the seventh and eighth thoracic vertebra, the right postzygapophysis is shorter than the left process. This is not true in *phaeus* or *fiber*, in which forms they are of equal length.

There is a tendency for the rudimentary metapophysis to occur on the tenth, eleventh, and even on the twelfth thoracic vertebra of *subauratus*, while in *belugae*, *fiber*, and *leucodonta* this process is found on the ninth and tenth thoracic vertebrae, or on the tenth only. This process articulates with the postzygapophysis of the preceding vertebra. The exact location of this process is as follows: *subauratus*, tenth and eleventh, nos. 12654, 12688, and 16385; eleventh only, no. 8987; eleventh and twelfth, no. 8869; *leucodonta*, ninth and tenth, no. 12101; *belugae* and *fiber*, tenth only, nos. 4347, and 19229. This process does not occur, so far as the material at hand shows, in *phaeus*.

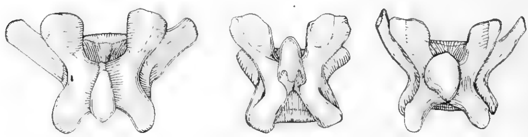
On the tenth thoracic vertebra of *phaeus* there is a tendency for the postzygapophysis to bifurcate and to have a dorsal as well as a ventral articulation with the prezygapophysis of the eleventh thoracic vertebra.

There is a tendency for the last four thoracic vertebrae of *subauratus* and *fiber* to have the articulating faces of the prezygapophyses and postzygapophyses inclined from the horizontal more than are the articulating faces in the three subspecies of *canadensis.*

In *subauratus* and *fiber,* on the thirteenth thoracic vertebra, the anapophyses are heavier than the same processes of the three subspecies of *canadensis.* In the last-named species and *fiber,* however, they are longer than in *subauratus.*

The average lateral extension of the metapophyses and anapophyses, measured from the lateral tip of the left to the lateral tip of the right process, and the ratios of the two widths at the thirteenth thoracic vertebra, are as follows:

	Metapophyses	Anapophyses	Ratio of widths of metapophyses to anapophyses
Castor fiber	21.88 mm.	33.74	65%
Castor subauratus	25.4	29.1	89
Three subspecies of Castor canadensis	24.2	30.5	79



M N O

Fig. M.—Dorsal view of second lumbar vertebra of *Castor fiber,* no. 19229. × ⅔.

Fig. N.—Dorsal view of second lumbar vertebra of *Castor subauratus,* no. 16385. × ⅔.

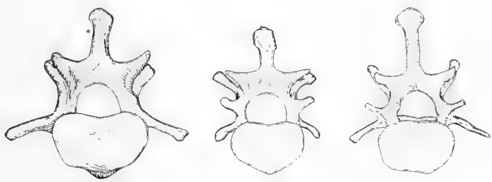
Fig. O.—Dorsal view of second lumbar vertebra of *Castor canadensis belugae,* no. 4347. × ⅔.

It will be noted from this table that the ratio of the width of the metapophyses is nearer unity in *subauratus* than in the three subspecies of *canadensis* or *fiber.*

In the lumbar vertebrae the transverse processes of the three subspecies of *canadensis* have a greater spread transversely than have those of *subauratus* (text-figs. M, N, O, P, Q, R). The shape of these processes also differs, the transverse processes in *subauratus* and *fiber* being nearly uniform in width from their origin at the pedicles to their extreme lateral portion; those of *belugae* taper near their lateral extremity, and in *leucodonta* and *phaeus* there is a sharp point at the very end (text-figs. M, N, O).

The mesial edges of the postzygapophyses of the lumbar vertebrae in *subauratus* form an angle with each other, while in the three subspecies of *canadensis* these edges form one continuous arc (text-figs. M, N, O). In *fiber* these edges, on the first two lumbar vertebrae, form an angle; but on the remaining vertebrae these edges are uneven. In the lumbar vertebrae of *subauratus* and *fiber* there are one or two well-developed foramina on the ventral surface of the centra, while in the three forms of *canadensis* these foramina appear only on the last or the next to the last vertebra.

In the series of *subauratus* the anapophyses, which occur on the first, second, and even the third lumbar vertebrae, have a tendency to form an articulating surface with the metapophyses following (text-figs. M, N, O); in *fiber* and in the three subspecies of *canadensis* these processes do not articulate with each other.



P Q R

Fig. P.—Caudal view of second lumbar vertebra of *Castor fiber*, no. 19229. × 5/8.

Fig. Q.—Caudal view of second lumbar vertebra of *Castor subauratus*, no. 16385. × 5/8.

Fig. R.—Caudal view of second lumbar vertebra of *Castor canadensis belugae*, no. 4347. × 5/8.

Although the prezygapophyses of the third and the next to the last lumbar vertebrae extend laterally to a greater degree in *subauratus* and *fiber* than in the three subspecies of *canadensis*, the postzygapophyses of the same vertebrae extend laterally to a greater degree in *phaeus* than they do in *belugae*, *subauratus*, or *leucodonta*, while *fiber* exceeds even *phaeus* in this measurement.

The prezygapophyses of the last lumbar vertebra of *phaeus* spread laterally to a greater degree than do the same processes of *subauratus*, which in turn exceed those of *belugae* and *leucodonta*.

Number of differences noted between *Castor subauratus* and *Castor canadensis*, thirty-six. *Castor fiber* conforms with *subauratus* in twenty-one of these, and with *canadensis* in thirteen; two are unassigned.

Sacral Vertebrae

The term sacral vertebrae, as used throughout this paper, includes those vertebrae between the lumbar and caudal vertebrae which are firmly fused together and one or more of which are joined to the ilia. It is in this sense that the term is used by Owen (1866, p. 366), Morgan (1868, p. 51), and Flower (1876, p. 62); and this is essentially the definition given by Reynolds (1897, p. 16), although on page 452 of the same work he says that beavers have but one sacral vertebra.

There are five points where fusion between the sacral vertebrae may occur: the lateral extremities of the transverse processes; the prezygapophyses and postzygapophyses; the pedicles; the neural spines; and the centra (pl. 6).

Phaeus, belugae, and one specimen of *leucodonta* (no. 12107) have the first four vertebrae following the lumbars fused at all five points (pl. 6, figs. 14, 15). The second specimen of *leucodonta* (no. 12101) has the first three fused at all five points, but the fourth is fused to the third at the zygapophyses and the neural spines only (pl. 6, fig. 16). From this it will be seen that there is a decided tendency toward four sacral vertebrae in the three subspecies of *canadensis.* In *subauratus,* however, three is the usual number (pl. 6, figs. 9, 10, 11, 12). In none of the specimens of the latter are the centra of more than three vertebrae fused together (no. 16385 has only two), although no. 12668 has a peculiar dorsal epiphysis that joins the neural spines of the third and fourth vertebrae. The only specimen of *subauratus* which does not show three and only three sacral vertebrae is no. 8987, which has the third and fourth vertebrae fused at the neural spines and the pedicles.

Leucodonta, no. 12107, has well-developed rudimentary ribs, such as are to be seen in *Erethizon,* joining the second sacral vertebra to the ilia. This condition exists, but to a lesser degree, in nos. 210, 4347, 19229, and 12101, of *phaeus, belugae, fiber* and *leucodonta,* respectively. *Subauratus* does not show these rudimentary ribs in any of the specimens (pl. 6). From this it will be seen that, if Gegenbaur's definition (Flower, 1876, p. 25) for the sacral vertebrae were used, the three subspecies of *canadensis* would have two sacral vertebrae and *subauratus* one.

The neural spine of the three subspecies of *canadensis* on the first sacral vertebra is almost perpendicular, while in *subauratus* and *fiber* this process inclines slightly caudad.

With but one exception (no. 12654), *subauratus* and *fiber* have thickened lateral extremities on the transverse processes of the second and third sacral vertebrae, while the extremities of these processes in the three subspecies of *canadensis* come to a thin edge (pl. 6).

Number of differences noted between *Castor subauratus* and *Castor canadensis,* four. *Castor fiber* conforms with *canadensis* in two, and with *subauratus* in two.

Caudal Vertebrae

It has been impossible to ascertain the number of vertebrae in the caudal region of several of the specimens, since some segments have been lost from the caudal extremity. The following specimens have their full complement of caudal vertebrae:

	No.	Caudal vertebrae	Sacral vertebrae
Castor fiber	19229	25	4
C. c. leucodonta	12107	26	4
C. subauratus (adult)	12654	26	3
C. subauratus (adult)	16385	27	3
C. subauratus (juvenile)	16384	28	3

It will be seen that the number of caudal vertebrae is not constant in *subauratus.* The specimens described by Morgan (1868, p. 51), probably *Castor canadensis canadensis,* and Flower (1876, p. 67), probably the same species, had twenty-five caudal vertebrae.

The lateral extension of the postzygapophyses of the first three caudal vertebrae is greater in *subauratus* than in the three subspecies of *canadensis.* There is also a tendency for the prezygapophyses in *subauratus* to have greater lateral extension than those in *fiber* or *canadensis.*

Only the first four caudal vertebrae of *subauratus* bear neural spines, while in *phaeus* and *fiber* the first seven, and in *leucodonta* and *belugae* the first six have this process.

The postzygapophyses of the first five or six of the caudal vertebrae project posterior of the centra in *subauratus* and *fiber,* but in the three subspecies of *canadensis* these processes project beyond the centra on only the first three.

There is a tendency for the prezygapophyses and the postzygapophyses of *subauratus* and *fiber* to be more nearly perpendicular to the dorsoventral axis, while the three subspecies of *canadensis* have these articulating faces set at an angle to this axis.

As a rule, the transverse processes which extend farthest laterally are borne on the first caudal vertebra in *canadensis;* in *subauratus* on the fourth; and in *fiber* on the second.

Number of differences noted between *Castor subauratus* and *Castor canadensis*, eleven. *Fiber* conforms with *subauratus* in three; with *canadensis* in four; and four are indeterminate.

Ribs and Sternum

There is a tendency for the first six ribs in the three subspecies of *Castor canadensis* and in *Castor fiber* to be flattened upon the transverse axis to a greater degree than are the ribs of *subauratus.*

Owen (1866, p. 364) gives the number of ribs in *Castor* as fifteen pairs. This is the number found in *subauratus,* but not in *fiber* or in the three subspecies of *canadensis,* which have fourteen. There are, however, only seven pairs of true ribs in *subauratus* and the three subspecies of *canadensis;* while Owen (1866, p. 366) gives the number in *Castor* as eight. Morgan (1868, p. 52), who was describing *canadensis,* records seven pairs of true ribs.

The sternum of *subauratus* and *fiber* is broader and thicker than is the sternum in the three forms of *canadensis.*

Number of differences noted between *Castor subauratus* and *Castor canadensis*, four. *Fiber* conforms with *subauratus* in two of these and with *canadensis* in two.

Scapula

The suprascapular border tends to be straighter in *subauratus* and *fiber* than in the three subspecies of *canadensis* (pl. 7). In the last named forms the vertebral margin (BNA) follows the arc of a circle with its center located near the glenoid border, while in *subauratus* and *fiber* the center of the arc of this border is located near the spine (pl. 7). The glenoid border is thicker in *subauratus* than in the three forms of *canadensis.*

The spine tends to originate at its dorsal extremity closer to the coracoid border in *fiber* and in the three forms of *canadensis* than it does in *subauratus* (pl. 7). About half-way between the acromion and the suprascapular border there is a decided ventral twist to the lateral portion of the spine in the three forms of *canadensis,* while the spine of *subauratus* and *fiber* is comparatively straight (pl. 7). The lateral portion of the spine in *subauratus* and *fiber* has a projecting edge on its glenoid side, which extends from the acromion about two-thirds of the way to the suprascapular border; in the three subspecies of *canadensis* this projecting edge is shorter, ending where the spine twists ventrad.

The angle formed by the glenoid border and the coracoid border, if produced, is greater in *subauratus* than in *fiber* or in the three forms of *canadensis*, or, it might be said, these borders approach each other more rapidly in *subauratus*. *Fiber* and the three forms of *canadensis* have a more nearly sharp-cornered superior angle than has *subauratus* (pl. 7). The coracoid process of *subauratus* and *fiber* has a much sharper point than it has in the other three forms, but it is heavier in *canadensis* and *fiber*. The ventral extremity of the acromion tends to be more nearly styliform and narrower in the three subspecies of *canadensis* than in *subauratus* or in *fiber*.

Number of differences noted between *Castor subauratus* and *Castor canadensis*, twelve. *Fiber* conforms with *subauratus* in seven; with *canadensis* in four; and one is indeterminate.

Clavicle

The shaft of the clavicle in *Castor subauratus*, if projected upon the dorsoventral and cephalocaudal planes, would describe arcs, the center on the first of which would be located mediodorsad, and that of the second, laterocephalad (pl. 8, figs. 30 to 37). In the three forms of *Castor canadensis* and in *Castor fiber* the shaft is straight. On the costal surface, near the dorsal edge and about one centimeter from the acromial extremity, there is a small fossa, evidently for the attachment of muscle; this is deeper in *subauratus* and *fiber* than in the other forms.

Number of differences noted between *Castor subauratus* and *Castor canadensis*, three. *Fiber* conforms with *subauratus* in one, and with *canadensis* in two.

Humerus

The base of the epiphysis of the greater tuberosity is broader in its anteroposterior dimension in *Castor fiber* and in the three subspecies of *Castor canadensis* than in *Castor subauratus*. The bicipital groove is longer and deeper in *fiber* and in the three forms of *canadensis* than it is in *subauratus* (pl. 9). The olecranon fossa is more clearly defined in the three subspecies of *canadensis* than in *subauratus* or in *fiber*. The proximal surface of the deltoid ridge has a tendency to be flattened transversely in *leucodonta* and *phaeus*, but not in *subauratus, fiber*, or *belugae*. The proximal origin of the deltoid ridge is more distally located in the three forms of *canadensis* than in *subauratus* or *fiber* (pl. 9). There is a marked difference in the form of the internal condyle; in *fiber* and in the three forms of *canadensis* it is greater in its longitudinal measurement than in *subauratus*, and in *subauratus* its transverse dimension is greater than in *fiber* or in the three subspecies of *canadensis*.

The supinator ridge is heavier and more inclined to have an anterolateral ridge in *subauratus* and *fiber* than in the three subspecies of *canadensis* (pl. 9). In *subauratus* and *fiber* the supinator ridge forms an even curve, while in the three subspecies of *canadensis* there is an easily discerned angle about half-way between the shaft and the external condyle.

There is a small tuberosity on the lateral anterosuperior surface of the trochlea in *subauratus* which does not exist in any of the other four forms (pl. 9, figs. 38, 39, 40, 41). The capitulum has a tendency to be heavier in *belugae* and *phaeus* than in *subauratus, fiber*, or *leucodonta*.

In *subauratus* and *fiber* the anterior distal articulating surfaces are wider, in comparison with the greatest width of the distal extremity of the humerus, than is the case with the three subspecies of *canadensis*. This is shown in the following table:

	Width art. surfaces	Width dist. extremity	Ratio, per cent
Subspecies of Castor canadensis (three specimens)	18.9 mm.	32.3 mm.	58.5
Castor fiber (one specimen)	20.8	31.0	67.0
Castor subauratus (five specimens)	19.2	30.9	62.1

The distal wall of the small ellipsoidal fossa on the posterior surface of the internal condyle is heavier in *fiber* and in the three subspecies of *canadensis* than it is in *subauratus*.

The supinator ridge extends laterally farther from the distal articulating surfaces in *canadensis* than in *subauratus* or *fiber* (pl. 9).

Number of differences noted between *Castor canadensis* and *Castor subauratus*, sixteen. *Fiber* conforms with *subauratus* in nine and with *canadensis* in seven.

Radius

The plane of the proximal articulating surface of the radius makes an angle of about ninety degrees with the shaft of the radius in the three subspecies of *Castor canadensis*, and in *Castor fiber*, while in *Castor subauratus* the superior margin of the proximal epiphysis is tipped distally, so that the plane of this articulating surface makes a more acute angle with the axis of the radius (pl. 10). The greatest diameter of the neck of the radius is less in the three subspecies of *canadensis* than in *subauratus* or *fiber*: *canadensis* averages 6.10 mm.; *subauratus* 7.94; *fiber* 7.65. On account of this greater constriction at the neck of the radius, the head rises more abruptly from the shaft in the three subspecies of *canadensis*. The most lateral portion of the head bears a small tubercle in the three forms of *canadensis* which, in *subauratus* and *fiber*, is not so well developed (pl. 10). Proximad and mediad to the bicipital tuberosity is a well-marked fossa which is developed to a greater degree in *subauratus* than in *fiber* or in the three subspecies of *canadensis*. In the three forms of *canadensis* the sigmoid cavity is deeper than it is in *subauratus* or *fiber*.

Number of differences noted between *Castor canadensis* and *Castor subauratus*, six. *Castor fiber* conforms with *subauratus* in four of these and with *canadensis* in two.

Ulna

On the external face of the olecranon, near the posterior edge, there is a well-defined crest in the three subspecies of *Castor canadensis*. In *Castor subauratus* and *Castor fiber* this is not developed to such a degree, but is seen as a line rather than as a crest (pl. 10).

The anterior edge of the olecranon is thinner in the three subspecies of *canadensis* than in *subauratus* or *fiber*. This is in part due to the increased depth of the fossa located on the internal surface of the ulna below and proximad to the greater sigmoid notch. This fossa, in the three forms of *canadensis*, lies close to the superior edge of the olecranon, while in *subauratus* it lies farther posteriorly from this edge. The mesial edge of the coronoid process is thicker in *subauratus* and *fiber* than in the three forms of *canadensis;* in the latter this edge is sharp. The lateral edge of the lesser sigmoid cavity is also thicker in the case of *subauratus* and *fiber* than in the three subspecies of *canadensis*. Laterad to the lesser sigmoid cavity is a tuberculum which is less developed in *subauratus* and *fiber* than in the forms of *canadensis*.

The under surface of the ulna from the point of the olecranon to a point beneath the greater sigmoid cavity has, in the three subspecies of *canadensis,* the appearance of having been roughly modeled with a smooth, flat tool. This gives several smooth, flat surfaces, with more or less well-defined edges between them. In *subauratus* and *fiber* this surface is rounded, having no flat surfaces or well-defined edges.

Immediately below the interosseous crest is a fossa which ends rather abruptly proximad in the three forms of *canadensis* and in *fiber,* while in *subauratus* it comes gradually to the surface (pl. 10). The minimum diameter of the shaft, which occurs near the distal extremity, is less in *subauratus* than in *canadensis* or *fiber: subauratus* measures 4.60 mm.; *canadensis* 5.17; *fiber* 6.50. In the three subspecies of *canadensis* the greatest diameter of the distal epiphysis is less in comparison with the total length of the epiphysis than in *subauratus* or *fiber:* the ratio of the diameter to length in *canadensis* is 76.1 per cent; *subauratus* 84.8; *fiber* 89.3 (pl. 10).

Number of differences noted between *Castor canadensis* and *Castor subauratus,* ten. *Fiber* conforms with *subauratus* in six, with *canadensis* in two, and two of the differences are unassigned.

Os Innominatum

There is a tendency for the iliac portion of the acetabulum to be deeper and longer anteriorly in *Castor subauratus* than in the three forms of *canadensis.* Those portions of the ischium and pubis which form the base of the acetabulum are thicker in *subauratus* and *fiber* than in the three forms of *canadensis.* On the posterior dorsal edge of the acetabulum the lunate surfaces project farther ventrad in *subauratus* than in the three subspecies of *canadensis,* or in *fiber* (pl. 11).

Ventral to the acetabulum is a square angle in *fiber, subauratus,* and *phaeus,* which does not occur in *leucodonta* or *belugae.*

Number of differences noted between *Castor subauratus* and *Castor canadensis,* four. *Fiber* conforms with *canadensis* in two, and with *subauratus* in one.

Femur

In *Castor subauratus* the depression in the head of the femur is deeper than in the three subspecies of *Castor canadensis* or in *Castor fiber.* The diameter of this depression in *subauratus* and *fiber* is greater than in the forms of *canadensis*. The epiphysis of the great trochanter forms with the shaft an angle that, in *subauratus* and *fiber,* is nearer 90 degrees than it is in any of the three subspecies of *canadensis* (pl. 12). In the three last-mentioned forms and in *fiber* the intertrochanteric line is more clearly defined than in *subauratus*. The lesser trochanter in *subauratus* and *fiber* has a flattish epiphysis which faces proximad and mesiad, while in the three forms of *canadensis* the lesser trochanter ends in a moderately sharp point (pl. 12). Directly anterior to the lesser trochanter, on the mesial side of the shaft of the femur, is a fossa which is deeper in *subauratus, fiber,* and *belugae* than in *leucodonta* or *phaeus*. The third trochanter (see Owen, 1866, p. 381, for name) in the three forms of *canadensis* is less blunt at its lateral extremity than in *subauratus* or *fiber* (pl. 12).

Number of differences noted between *Castor subauratus* and *Castor canadensis,* eight. *Castor fiber* conforms with *subauratus* in six, and with *canadensis* in two.

Tibia

The tibia is longer in comparison with the length of the femur in the three subspecies of *Castor canadensis* than it is in *Castor subauratus* or *Castor fiber.* The difference between *subauratus* and *phaeus,* however, is slight, as will be seen from the following table:

	Femur	Tibia	Ratio, per cent
C. c. phaeus	106.6 mm.	131.6 mm.	81.1
C. c. belugae and leucodonta	103.9	132.8	78.2
C. subauratus (average of five)	105.7	129.4	81.7
C. fiber	108.5	132.9	81.6

Anterior to the anterior condyloid fossa there is a tuberosity which is much sharper in the three forms of *canadensis* than in *subauratus* or *fiber.* In all five forms of beaver the posterior face is deeply concave; but in *subauratus* and *fiber* the condyloid fossa ends much less abruptly proximad than it does in the three forms of *canadensis.*

Subauratus and *fiber* have heavier interosseous crests than have the three subspecies of *canadensis.* The malleolar groove is also wider in *subauratus* and *fiber* than in the three forms of *canadensis,* but is deeper and longer in the three last-mentioned forms and in *fiber.* The posterior margin, or rim, of the malleolar groove is thinner in the three subspecies of *canadensis* than in *subauratus* or *fiber.*

At the distal extremity of the posterior face there is a process which has a much sharper point in *subauratus* than in the three subspecies of *canadensis* or in *fiber;* but this process is smaller in *subauratus* and *fiber.*

Number of differences noted between *Castor subauratus* and *Castor canadensis,* ten. *Castor fiber* conforms with *subauratus* in seven and with *canadensis* in three.

Fibula

The angle which the hamular process (see Morgan, 1868, p. 54, for name) makes with the shaft of the fibula approximates, in *Castor subauratus* and *Castor fiber,* ninety degrees, and is decidedly less than ninety degrees in the three subspecies of *Castor canadensis* (see pl. 8, figs. 25 to 29).

On the proximal third of the fibula the following differences occur: in the three subspecies of *canadensis* and in *fiber* the lateral face has a decided tendency to be concave, while in *subauratus* there is a tendency toward convexity. In the three forms of *canadensis* and in *fiber* there is a well-defined posterior face which joins the medial face in a sharp-edged medial crest, the medial face being slightly concave. In *subauratus* the medial and posterior faces are poorly defined and the medial crest is but a faintly indicated line (pl. 8, figs. 25 to 29).

Proximad, and directly anterior to the face for the articulation of the tibia, the fibula in *subauratus* and *fiber* presents a small, flat face, while in the three subspecies of *canadensis* there is a sharp crest at this point.

The distal epiphysis has proximally pointing projections which are claw-shaped in the three forms of *canadensis* but are less developed in *subauratus* or *fiber.*

On the proximal posterolateral margin of the hamular process in *canadensis* is a crest which does not occur in *subauratus* or *fiber.*

On the posterior face of the distal epiphysis is a sulcus which is wider in the three forms of *canadensis* and in *fiber* than in *subauratus.* The medial face of the external malleolus tends to be convex in *canadensis,* while in *subauratus* and *fiber* this articulating face presents the appearance of having been ground and is concave.

Number of differences noted between *Castor subauratus* and *Castor canadensis,* eight. *Castor fiber* conforms with *subauratus* in five and with *canadensis* in three.

Astragalus

On the medial side of the body of the astragalus is a tuberosity which is developed to a greater degree in the three subspecies of *Castor canadensis* than in *Castor subauratus* or *Castor fiber.* The groove on the medioposterior edge extends farther laterad in the three forms of *canadensis* than it does in *subauratus.* The lateral border of the head of the astragalus is twisted upward more in *subauratus* than in the three subspecies of *canadensis* or *fiber.* The median articulating face for the calcaneum is broader posteriorly in *belugae, fiber,* and *phaeus* than it is in *leucodonta* or *subauratus.*

Number of differences noted between *Castor subauratus* and *Castor canadensis,* four. *Castor fiber* conforms with *subauratus* in two, and with *canadensis* in two.

Calcaneum

In the three subspecies of *Castor canadensis* there is a well-defined medial tuberosity which is lacking in *Castor subauratus* and *Castor fiber.* In the three forms of *canadensis* and in *fiber* the median and anterior articulating faces make an angle anteriorly of about forty-five degrees with the axis of the calcaneum, while in *subauratus* they make an angle of about thirty degrees. There is a decided tendency for the sustentaculum of *subauratus* to be more rounded mediad than it is in the three subspecies of *canadensis.*

The plantar surface of the calcaneum in the three forms of *canadensis* and in *fiber* is wider and more uniform in width for its entire length than it is in *subauratus,* where there is a tendency for it to have a constriction directly below the sustentaculum.

On the distal margin of the lateral face of the body is a process which is more highly developed in *canadensis* than in *subauratus* or *fiber.* As viewed from the plantar surface, the body of the calcaneum is less curved in *subauratus* and *fiber* than it is in *canadensis.*

Number of differences noted between *Castor subauratus* and *Castor canadensis,* seven. *Castor fiber* conforms with *subauratus* in three, and with *canadensis* in three.

Total number of differences noted between *Castor subauratus* and *Castor canadensis,* 156. *Castor fiber* conforms with *subauratus* in eighty-nine (58 per cent); with *canadensis* in fifty-three (33 per cent); and fourteen (9 per cent) are not clearly subject to assignment.

Tabulation of the Differences Noted in the Bones of the Limbs and of the Pectoral and Pelvic Girdles

	Castor canadensis	*Castor subauratus*	*Castor fiber*
Scapula (see pl. 7)			
suprascapular border	follows arc of circle	straighter	straighter
dorsal origin of spine	closer to coracoid border	farther from coracoid border	closer to coracoid border
glenoid border	thinner	thicker	intermediate
spine	twisted	straighter	straighter
projecting edge on glenoid side of spine	from acromion to twist	from acromion two-thirds the way to the suprascapular border	same as in *subauratus*
angle formed by glenoid and coracoid borders, produced	less	greater	less
superior angle	more angular	less angular	more angular
coracoid process	blunter and heavier	sharper and lighter	sharper and heavier
acromion, ventral extremity	more styliform and narrower	less styliform and broader	less styliform and broader
Clavicle (see pl. 8, figs. 30 to 37)			
shaft	straighter	curved on two centers	straighter
fossa on costal surface	less developed	more developed	more developed
Humerus (see pl. 9)			
epiphysis of greater tuberosity, antero-posterior measurement at base	greater	less	greater
bicipital groove	longer and deeper	shorter and more shallow	longer and deeper
olecranon fossa	clearly defined	obscurely defined	obscurely defined
deltoid ridge, proximal surface	flattened transversely	not flattened	not flattened
deltoid ridge, proximal origin	more distally located	more proximally located	more proximally located
internal condyle, longitudinally	longer	shorter	longer
internal condyle, transversely	narrower	broader	narrower
supinator ridge	thin and angular	heavier, with even curve	heavier and angular
tuberosity on latero-anterosuperior surface of the trochlea	absent	present	absent

TABULATION OF THE DIFFERENCES NOTED IN THE BONES OF THE LIMBS AND OF THE PECTORAL AND PELVIC GIRDLES—(*Continued*)

	Castor canadensis	*Castor subauratus*	*Castor fiber*
ratio of distal articulating surface to the width of distal extremity	58.5 per cent	62.1 per cent	67.0 per cent
distal boundary of ellipsoidal fossa on posterior surface of internal condyle	heavier	thinner	heavier
Radius (see pl. 10, figs. 47, 49, 51, 53, 55, 57, 59, 61)			
angle of plane of proximal articulating surface with axis of radius	nearly 90 degrees	more acute	nearly 90 degrees
greatest diameter of neck	6.10 mm.	7.94 mm.	7.65 mm.
slope from neck to head	abrupt	more gradual	more gradual
tubercle on lateral portion of head	more developed	less developed	less developed
fossa proximad and mediad to bicipital tuberosity	less developed	more developed	less developed
sigmoid cavity	deeper	shallower	shallower
Ulna (see pl. 10, figs. 46, 48, 50, 52, 54, 56, 58, 60)			
crest on external face of olecranon near posterior edge	well defined	a line	a line
anterior edge of olecranon	thinner	thicker	thicker
mesial edge of coronoid process	thinner	thicker	thicker
tuberculum laterad to lesser sigmoid cavity	well developed	less developed	less developed
under surface of olecranon	has smooth flat surfaces	smoothly rounded	smoothly rounded
fossa posterior to interosseal crest	ends abruptly proximad	comes gradually to surface	ends abruptly
minimum diameter of shaft (average)	5.17 mm.	4.60 mm.	6.50 mm.
ratio of greatest diameter of distal epiphysis to length of epiphysis	76.1 per cent	84.8 per cent	89.3 per cent
Os Innominatum (see pl. 11)			
iliac portion of acetabulum	shallower, less prolonged	deeper, more prolonged	indeterminate

Tabulation of the Differences Noted in the Bones of the Limbs and of the Pectoral and Pelvic Girdles—(*Continued*)

	Castor canadensis	*Castor subauratus*	*Castor fiber*
base of acetabular notch	thinner	thicker	thinner
ventral projection of lunate surfaces	less	greater	less
Femur (see pl. 12)	shallower	deeper	shallower
pit in head of femur	smaller in diameter	larger in diameter	larger in diameter
angle of epiphysis of great trochanter with shaft	not so near 90 degrees	nearer 90 degrees	nearer 90 degrees
intertrochanteric line	more clearly defined	less clearly defined	more clearly defined
lesser trochanter	ends in sharp point	has flattish epiphysis	has flattish epiphysis
fossa anterior to lesser trochanter	shallower	deeper	deeper
third trochanter, lateral extremity	less blunt	more blunt	more blunt
Tibia			
ratio of femur to tibia	81.1 per cent (*phaeus*) 78.2 per cent (*canadensis* and *leucodonta*)	81.7 per cent	81.6 per cent
tuberosity anterior to intercondyloid fossa	sharper	blunter	blunter
posterior face	more abruptly concave	less abrupt	less abrupt
interosseous crest	thinner	heavier	heavier
malleolar groove	narrower, deeper, longer	wider, shallower, shorter	wider, deeper, longer
posterior rim of malleolar groove	thinner	thicker	thicker
most distal process	blunter, larger	sharper, smaller	blunter, smaller
Fibula (see pl. 8, figs. 25 to 29)			
angle of hamular process with shaft of fibula	not so near 90 degrees	nearer 90 degrees	nearer 90 degrees
lateral face	concave	convex	concave
posterior face	well defined	poorly defined	well defined
proximad and anterior to face for articulation to tibia	sharp crest	flattish face	flattish face
medial face of external malleolus	convex	concave	concave

GENERAL OBSERVATIONS

It has not been possible to formulate any one general statement covering the differences between the three species of *Castor*. The fact that *subauratus* has one more thoracic-lumbar vertebra might signify that, in this character at least, *subauratus* is the most primitive form.

The three subspecies of *canadensis* are more closely related, *inter se,* than is *subauratus* or *fiber* to any one of them. Also it is to be seen that *subauratus* and *fiber* are more closely related than *fiber* and *canadensis.* The differences, however, between *subauratus* and *fiber* are so great as to preclude consideration of these two forms as conspecific. The relative similarity, however, brings forward many interesting questions, to which no attempt is here made to give answers.

Transmitted August 4, 1916.

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PLATE 5

Cephalic view of the first (upper row) and the thirteenth (lower row) thoracic vertebrae; about nine-tenths natural size.

Figs. 1 and 5. No. 19229, *Castor fiber.*

Figs. 2 and 6. No. 210, *Castor canadensis phaeus.*

Figs. 3 and 7. No. 4347, *Castor canadensis belugae.*

Figs. 4 and 8. No. 16385, *Castor subauratus.*

Note that in *subauratus* and *fiber* the first thoracic vertebra, figures 1 and 4, has a broader neural canal, and that in *subauratus*, figure 4, the height is greater; that the ''hauteur totale du corps de la vertèbre'' in the first thoracic vertebra is greater in *subauratus* and *fiber,* and that on the thirteenth *canadensis* shows this measurement to be greatest; that there is a tendency for *fiber* and *canadensis* to have larger centra.

7

PLATE 6

Ventral view of the vertebrae from the sacral region; about one-half natural size.

Fig. 9. No. 8987, *Castor subauratus.*
Fig. 10. No. 12654, *Castor subauratus*
Fig. 11. No. 12668, *Castor subauratus.*
Fig. 12. No. 16385, *Castor subauratus.*
Fig. 13. No. 19229, *Castor fiber.*
Fig. 14. No. 210, *Castor canadensis phaeus.*
Fig. 15. No. 4347, *Castor canadensis belugae.*
Fig. 16. No. 12101, *Castor canadensis leucodonta.*

Note that the centra of the first four vertebrae of *fiber, belugae,* and *phaeus* are fused, while in *subauratus* and *leucodonta* only three of the vertebrae are so joined (no. 16385 having only two). The lateral portions of the transverse processes of the third and fourth vertebrae can be seen to be thinner in *canadensis* (and one specimen, no. 12654, of *subauratus*) than in *fiber* or *subauratus.* The presence of the second rudimentary rib in *fiber,* and the tendency for *canadensis* to have a second rib to the ilium, can also be seen.

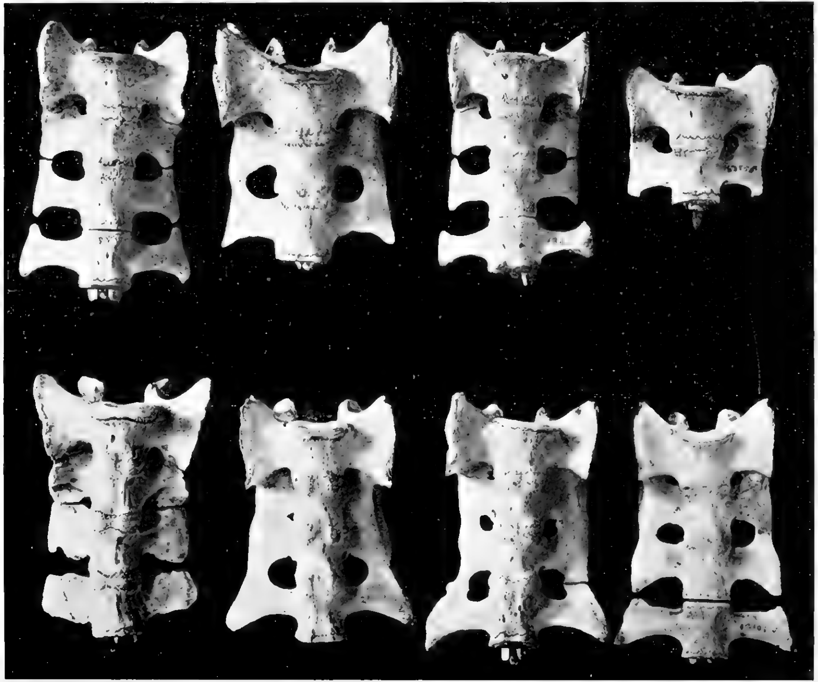


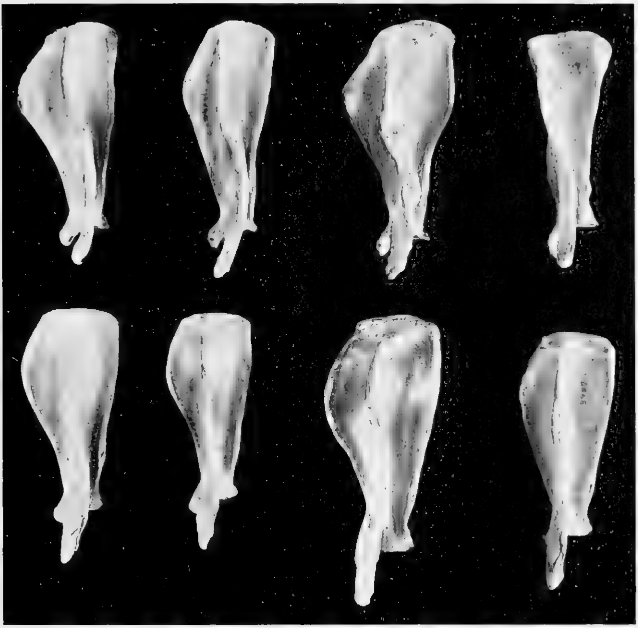
PLATE 7

Lateral view of the left scapula; about one-half natural size.

Fig. 17. No. 8987, *Castor subauratus.*
Fig. 18. No. 12654, *Castor subauratus.*
Fig. 19. No. 12668, *Castor subauratus.*
Fig. 20. No. 16385, *Castor subauratus.*
Fig. 21. No. 19229, *Castor fiber.*
Fig. 22. No. 210, *Castor canadensis phaeus.*
Fig. 23. No. 4347, *Castor canadensis belugae.*
Fig. 24. No. 12101, *Castor canadensis leucodonta.*

Note that the suprascapular border is more nearly straight in *fiber* and *subauratus* than in *canadensis;* that the spine tends to originate at its dorsal extremity closer to the coracoid border in *fiber* and *canadensis;* the lateral twist of the spine in *canadensis* and the comparatively straight spine in *fiber* and *subauratus;* that the angle of the glenoid and coracoid borders, if produced, is greatest in *subauratus;* that the superior angle is in *canadensis* more angular.

21 23 12 2



20 1 3

PLATE 8

Costal surface of the left clavicle and the tibial surface of the left fibula; about two-thirds natural size.

Figs. 25 and 35. No. 210, *Castor canadensis phaeus.*

Figs. 26 and 37. No. 12101, *Castor canadensis leucodonta.*

Figs. 27 and 34. No. 19229, *Castor fiber.*

Fig. 28. No. 8869, *Castor subauratus.*

Figs. 29 and 33. No. 16385, *Castor subauratus.*

Fig. 30. No. 8987, *Castor subauratus.*

Fig. 31. No. 12654, *Castor subauratus.*

Fig. 32. No. 12668, *Castor subauratus.*

Fig. 36. No. 4347, *Castor canadensis belugae.*

Note that the angle which the hamular process makes with the shaft of the fibula is greater in *subauratus* and *fiber* than in *canadensis;* that the shafts of the clavicles of *subauratus* are curved, in *canadensis* and *fiber* they are straight; that the fossa near the dorsal edge is deeper in *fiber* and *subauratus* than in *canadensis.*

PLATE 9

Anterior surface of left humerus; about one-half natural size.

Fig. 38. No. 8987, *Castor subauratus.*
Fig. 39. No. 12654, *Castor subauratus.*
Fig. 40. No. 12668, *Castor subauratus.*
Fig. 41. No. 16385, *Castor subauratus.*
Fig. 42. No. 19229, *Castor fiber.*
Fig. 43. No. 210, *Castor canadensis phaeus.*
Fig. 44. No. 4347, *Castor canadensis belugae.*
Fig. 45. No. 12101, *Castor canadensis leucodonta.*

Note that the bicipital groove is deeper and larger in *canadensis* and *fiber* than in *subauratus.* The proximal origin of the deltoid ridge is more distally located in *canadensis* than in *subauratus* or *fiber;* the longitudinal measurement of the internal condyle is greater in *fiber* and *canadensis;* the supinator ridge forms an even curve in *fiber* and *subauratus,* but an angle in *canadensis.*

38 39 40 41

42 43 44 45

PLATE 10

Lateral surface of the left ulna and radius; about two-fifths natural size.

Figs. 46 and 47. No. 8987, *Castor subauratus.*

Figs. 48 and 49. No. 12654, *Castor subauratus.*

Figs. 50 and 51. No. 12668, *Castor subauratus.*

Figs. 52 and 53. No. 16385, *Castor subauratus.*

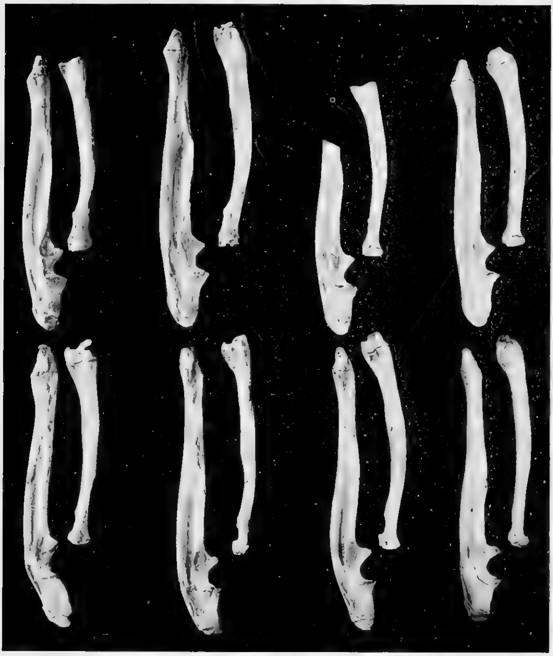
Figs. 54 and 55. No. 19229, *Castor fiber.*

Figs. 56 and 57. No. 210, *Castor canadensis phaeus.*

Figs. 58 and 59. No. 4347, *Castor canadensis belugae.*

Figs. 60 and 61. No. 12101, *Castor canadensis leucodonta.*

Note that the plane of the proximal articulating face of the radius is set at an angle of about 90 degrees with the shaft in *fiber* and *canadensis,* but is tilted in *subauratus;* the greatest diameter of the neck of the radius is less in *canadensis;* the head of the radius rises more abruptly in *canadensis.* In *subauratus* the fossa below the interosseous crest is shallower, at its proximal end, than in *canadensis* and *fiber.*



54 55 56 57 58 59 60 61

PLATE 11

View of left os innominatum, showing the acetabulum; about three-fifths natural size.

Fig. 62. No. 16385, *Castor subauratus.*

Fig. 63. No. 4347, *Castor canadensis belugae.*

Fig. 64. No. 19229, *Castor fiber.*

Note that there is a square angle ventral to the acetabulum in *subauratus* and *fiber*, but not in *belugae.*

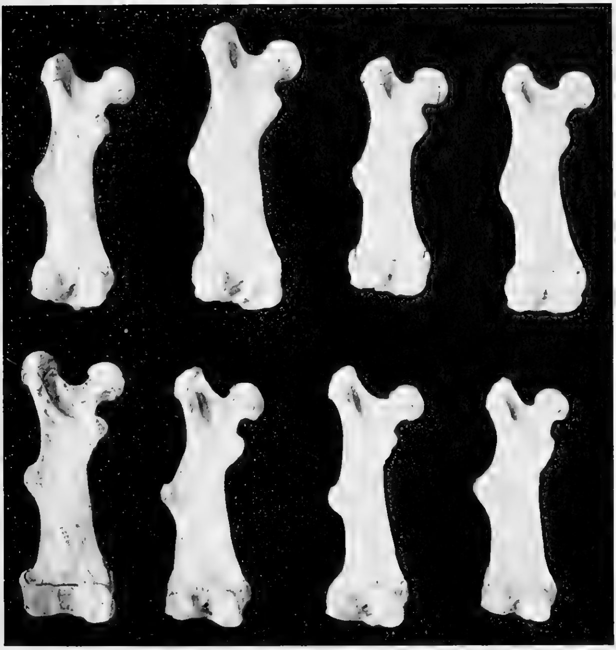
62 63 64

PLATE 12

View of posterior surface of the left femur; about two-fifths natural size.

Fig. 65. No. 8987, *Castor subauratus.*
Fig. 66. No. 12654, *Castor subauratus.*
Fig. 67. No. 12668, *Castor subauratus.*
Fig. 68. No. 16385, *Castor subauratus.*
Fig. 69. No. 19229, *Castor fiber.*
Fig. 70. No. 210, *Castor canadensis phaeus.*
Fig. 71. No. 4347, *Castor canadensis belugae.*
Fig. 72. No. 12101, *Castor canadensis leucodonta.*

Note that the epiphysis of the great trochanter forms an angle nearer ninety degrees with the shaft, in *subauratus* and *fiber* than in *canadensis;* that in *fiber* and *canadensis* the intertrochanteric line is more clearly defined than in *subauratus;* that the lesser trochanter of *fiber* and *subauratus* has an epiphysis, but that it does not occur in the forms of *canadensis;* that the third trochanter of *canadensis* is sharper than that of *fiber* or *subauratus.*



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NOTES ON THE SYSTEMATIC STATUS OF THE TOADS AND FROGS OF CALIFORNIA

BY

CHARLES LEWIS CAMP

UNIVERSITY OF CALIFORNIA PRESS
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Vol. 17, No. 9, pp. 115-125, 3 text figures February 3, 1917

NOTES ON THE SYSTEMATIC STATUS OF THE TOADS AND FROGS OF CALIFORNIA

BY
CHARLES LEWIS CAMP
(Contribution from the Museum of Vertebrate Zoology of the University of California)

The large series of amphibians contained in the collection of the Museum of Vertebrate Zoology at the University of California has been at the writer's disposal for study and has furnished opportunity for looking into the status of certain California toads and frogs. Through the courtesy of Dr. Leonhard Stejneger, Head Curator in the Department of Biology of the United States National Museum, the writer was accorded the privilege of examining specimens in that museum, where the types of nearly all of the western species of frogs and toads are preserved.

As a result of this study it is found necessary to consider the two long recognized forms, *Bufo halophilus* and *Bufo boreas*, as subspecies of one species, and to put *Bufo columbiensis* under the synonymy of *Bufo boreas boreas*. Two new races of that confusing species, *Rana boylii*, are described, and two other western frogs, *Rana draytonii* and *Rana aurora*, are placed together as subspecies of *aurora* because of the recognition of intergrades from the coast region of northern California. Notes are also given on the occurrence in California of *Bufo boreas nelsoni* and the two subspecies of *Rana pretiosa*.

Toads

Examination of about 370 toads of the several forms closely allied to *Bufo boreas*, from Alaska, Vancouver Island, eastern Washington, western Oregon, northern Nevada, and California, has convinced the writer that most of the characters that have been employed by various authors, including Baird and Girard (1854*a*, pp. 174–175, 378–380, 1854*b*, p. 301), Girard (1858, pp. 74–80, atlas, pl. 5, figs. 4–9, pl. 6, figs. 4–9), Boulenger (1882, pp. 284–285, 295–296), Cope (1889, pp. 267–271), Stejneger (1893, pp. 220–221), and Dickerson (1906, pp. 44, 113–116), to separate the so-called species *boreas* and *halophilus* (including *columbiensis*) cannot, in this variable group, be considered diagnostic. It would appear that some of the characters originally used to distinguish *boreas* from *columbiensis* are of sexual rather than specific difference. The male of *boreas* has smoother skin, longer fore-arm and hind limb, and perhaps longer first finger than the female. Roundness of snout as contrasted with the truncated condition considered as distinguishing *halophilus* is probably an age character, as also is the degree of adherence of the skin on top of the head to the skull. Other criteria, such as width of head, distance between eyes, and size of parotoid, seem to be individual differences. The "types" of *columbiensis* in the United States National Museum are all young specimens which I am unable to separate from *boreas*. Therefore, unless a hitherto unnoted difference exists between the toads of Puget Sound and those of the Columbia River, the name *columbiensis* must be dropped.

The only constant characters distinguishing *boreas* from *halophilus* in the specimens at hand are those of increase of pigmentation of the more northern form and decrease of webbing (best indicated by spread of hind foot) in the southern. On the basis of these two characters two subspecies of *boreas* may be separated—one, *Bufo boreas boreas,* inhabiting Washington, Oregon, northern Nevada, and northern California as far south as Eureka, Humboldt County, Sisson, Siskiyou County, and Mono County; the other, a southern subspecies, *Bufo boreas halophilus,* occurring from southernmost San Diego County north to the Gualala River, Sonoma County, to Oroville, Butte County, and to the vicinity of Independence, Inyo County. Specimens from localities in the intervening area show that intergradation between *boreas* and *halophilus* takes place.

The above two subspecies are not easily confused if both the type of coloration and the ratio of spread of hind foot to total length are taken into account, and the following key may be used to separate them.

1. Back either dark and unspotted *or* blotched and speckled between the blotches with small, dark dots on the light background; spread of hind foot from end of first to tip of fifth toe usually more than 36 per cent of the total body-length; maximum body-length 120 millimeters ...... *Bufo boreas boreas.*

1′. Back usually spotted or blotched (rarely with dark speckles between the blotches on the light background) and seldom wholly dark; spread of hind foot usually less than 36 per cent of total body-length; maximum body-length 101 millimeters ...... *Bufo boreas halophilus.*

The two toads from Owens Valley, Inyo County, California, referred by Stejneger (1893, pp. 220–221) to *Bufo boreas nelsoni,* appear to be *halophilus.* The rounded snout of these is paralleled in many half-grown *halophilus* in a series at hand from southern California.

Frogs

Examination of about 450 specimens of frogs, mostly contained in the Museum of Vertebrate Zoology, warrants an attempt to formulate a key to the Pacific Coast species—*Rana pretiosa, Rana aurora,* and *Rana boylii,* and their subspecies. It has been thought necessary to redefine *Rana boylii* and to describe two new races of this species, one from the high Sierra Nevada and the other from the mountains of southern California.

Rana boylii boylii Baird

California Yellow-legged Frog

Type locality.—California (Baird, 1856, p. 62); subsequently indicated as El Dorado, California (Cope, 1889, p. 447).

Synonyms.—*Rana pachyderma* Cope (1884, pp. 25–27), (types from McCloud River [= Baird, Shasta County], California, and Ashland, Oregon); *Rana pretiosa* (Yarrow and Henshaw, 1878, p. 1632), part [Kern River]; [?] *Rana temporaria pretiosa* (Cope, 1889, p. 434), part [Santa Barbara].

Description.—Vomerine teeth rudimentary, on two oblique ridges nearly meeting between and behind the nares (see fig. 3); tympanic region not darker than rest of head; upper labial ridge mottled or colored like rest of body and not distinctly lighter than rest of head; red never present in coloration (except in diseased individuals). The above characters are diagnostic of all three subspecies of *boylii.* Those characters which pertain to this subspecies alone are: hind leg long, inside angle of bent tarsus reaching at least to nares and usually beyond when leg is advanced along body; tibia elongate, reaching usually beyond anus when flexed and held at right angles to axis of body; fourth toe on reflexed hind foot never reaching beyond end of knee and often not quite to fold of skin below knee; head broad and pointed when viewed from above, its width two and one-third to two and two-thirds times in body-length; skin on back, legs and tympanum, thick and rough with minute brownish spines; color dorsally varying from nearly uniform black to light gray, greenish or brownish, with darker markings, if present, usually indistinct; there is always a patch of lighter color on top of head between nares and eyes, and behind this a darker area crossing posterior half of each eyelid and merging insensibly behind into the general dorsal coloration. *Boylii* is the smallest of the three subspecies, reaching a maximum body-length of only about 66 millimeters.

Material.—One hundred and seventy-seven specimens of *R. b. boylii* are contained in the Museum of Vertebrate Zoology, from the following localities in California: Cuddeback, Humboldt County; eight miles east of South Yolla Bolly Mountain, Trinity County; vicinity of Covelo, vicinity of Sherwood, near Mount Sanhedrin, and Gualala, Mendocino County; Gualala River, Freestone, and eight miles west of Cazadero, Sonoma County; Fairfax, San Anselmo, Lagunitas Creek, and Muir Woods, Marin County; Mill Creek near Tehama, Tehama County; Chambers Ravine near Oroville, Butte County; Winslow near Fruto, Glenn County; near Vacaville, Solano County; vicinity of Mount Diablo, Contra Costa County; Berkeley, Alameda County; Corral Hollow, San Joaquin County; Sweeney's ranch, 22 miles south of Los Baños, Merced County; Fyffe (3600 feet altitude), El Dorado County; Pleasant Valley (600 feet), vicinity of Coulterville (3000-3200 feet), and near Feliciana Mountain (3800 feet), Mariposa County; Farrington's ranch (6800 feet), near Williams Butte, Mono County; and Kern River near Bodfish, and Fay Creek (4100 feet), six miles north of Weldon, Kern County.

Distribution.—Except for a small area in southwestern Oregon, the range of *Rana boylii boylii* seems to lie entirely within the state of California. It includes the northwestern part of the state, east to the McCloud River, Shasta County, and to the western foothills of the Sierra Nevada below 4100 feet altitude. The form occurs also at Mono Lake; in the Sierras it has been taken south to the vicinity of Walker Pass, Kern County; but where it meets the range of *R. b. muscosa* along the coast is not known. Specimens from the vicinity of Walker Pass show a more contrasted pattern of coloration, possibly indicating approach to the southern subspecies, described next below.

Rana boylii muscosa, new subspecies

Sierra Madre Yellow-legged Frog

Type.—Female, adult; no. 771, Mus. Vert. Zool.; Arroyo Seco Cañon, at about 1300 feet altitude, near Pasadena, California; August 3, 1903; collected by J. Grinnell.

Diagnosis.—Like *Rana boylii boylii,* but attaining much larger size, and (except in young) with no light patch in front of dark areas across upper eyelids. Dorsal ground color usually lighter than in *R. b. boylii,* light yellow to brown, contrasting with the darker moss-like patches on the back. Tips of toes more expanded than in *boylii.*

Description.—Vomerine teeth on two oblique ridges between nares; head pointed in outline as viewed from above, broad, its width entering body-length two and two-thirds times; hind limbs long, posterior side of bent tarsus reaching forward to snout; fourth toe on hind foot reaching forward not quite to knee-fold; dorso-lateral fold indistinct, not pitted anteriorly; tympanum and area surrounding it very rough, beset with small tubercles; web of hind foot extending nearly to tips of toes; outer and inner metatarsal tubercles distinct; plantar tubercles very large; tips of toes expanded, disc-shaped; distal end of flexed tibia held at right angles to body reaching anus; color above dark yellow, with a reticulated pattern of moss-like dark patches; beneath, yellow, spotted with dusky on throat and chest; upper lip below eye, mottled.

Material.—Fifty-one specimens in the Museum of Vertebrate Zoology, from the following localities in southern California: San Jacinto Mountains: Keen's Camp (nos. 3804, 3805); Strawberry Valley, 6000 feet altitude (nos. 534, 550, 584); Fuller's Mill, 5600–5800 feet (nos. 278–287, 314); Schain's Ranch, 4900 feet (no. 353); Cabezon, 2000 feet (nos. 151, 177); and Snow Creek, near Whitewater, 2500 feet (nos. 79, 194–197); San Bernardino Mountains: Santa Ana River, 5500 feet (nos. 714, 715); Fish Creek, 6500 feet (nos. 772–774); and Barton Creek, 6000 feet (no. 4389); and San Gabriel Mountains: Cañons near Sierra Madre, 1200–3000 feet (nos. 4374–4377, 4388, 4855, 4856, 4868); West Fork San Gabriel River, 3000 feet (nos. 4378–4385); Arroyo Seco Cañon near Pasadena (nos. 770, 771); and Little Rock Creek Cañon, 4700 feet (nos. 4390, 4391).

Variations.—The dorsal color pattern in some specimens, particularly those from the San Gabriel Mountains, is different from anything found in *R. b. boylii.* The ground color is lighter in these specimens than in either of the two northern subspecies, and is thickly marked with the lichen-like dark patches from which the name is derived. In other specimens, especially those from the San Jacinto Mountains, the color is darker, becoming uniformly dark brown in a single individual from Strawberry Valley, one of the extreme southern stations for the species. Some of the San Jacinto Mountain specimens are blotched and spotted like *R. b. sierrae,* and many show cross-bars on the tibia. The skin is usually thickly studded with brownish, hispid points, as in many *boylii,* but in the type it happens to be smooth. The outer metatarsal tubercle is sometimes rudimentary. The head-width enters the body-length from two and one-third to two and two-thirds times.

Remarks.—The two very young specimens from Little Rock Creek Cañon show the light head patch of *R. b. boylii,* and the flexed tibia extends beyond the anus as in that form. There is thus a good chance that on the desert slope of the San Gabriel Mountains the frogs are *boylii* rather than *muscosa.* The *Phrynosoma blainvillii* of the northern San Gabriel Mountains (Pine Flats, Barley Flats, and the Upper Tujunga Cañon, 5000–5500 feet), and of the Sierra Liebre, is of the northern subspecies, *Ph. b. frontale;* the frogs here discussed may offer a parallel case.

Rana boylii muscosa inhabits the deeply cut valleys and gorges of the San Gabriel, San Bernardino, and San Jacinto Mountains, from at least the Arroyo Seco Cañon near Pasadena, on the northwest, to Keen's Camp, Riverside County, on the southeast. It readily climbs the steep rocks bordering the cañon streams, employing for this purpose the enlarged tips of the digits, and sits far above the water during the day; when alarmed it dives directly into the stream, kicks up the silt with its hind legs, and buries itself in the mud, so that pursuit is rendered difficult.

Rana boylii sierrae, new subspecies

Sierra Nevada Yellow-legged Frog

Type.—Female, adult; no. 3734, Mus. Vert. Zool.; Matlack Lake, 10,500 feet altitude, two miles southeast of Kearsarge Pass, Sierra Nevada, Inyo County, California; June 26, 1912; collected by H. S. Swarth; orig. no. 9901.

Synonyms.—*Rana aurora,* part (Stejneger, 1893, p. 225); *Rana pretiosa,* part (Stejneger, *loc. cit.*, p. 226); [?] *Rana pretiosa* (Yarrow and Henshaw, 1878, p. 1632), part [Lake Tahoe].

Diagnosis.—With the general characters of *Rana boylii boylii,* but hind leg usually shorter and head relatively narrower; tympanum smoother; and light patch on top of head wanting.

Description of type.—Vomerine teeth rudimentary, on two oblique ridges nearly meeting between and slightly behind nares (see fig. 2);

head viewed from above rounded in outline; head-width contained three times in body-length; hind limbs short, posterior side of bent tarsus reaching forward to anterior corner of eye; fourth toe on hind foot reaching forward to end of bent knee; dorso-lateral fold indistinct, strongly pitted anteriorly; tympanum nearly smooth, with scattered hispid points; web of hind foot very large, extending to tips of toes; outer metatarsal tubercle rudimentary, inner one small; plantar tubercles small; tips of toes not much expanded; distal end of flexed tibia, held at right angles to body, just reaching anus; color above, dark yellowish brown, obscurely marked with indefinite darker vermiculations; lower surface yellow, faintly dotted with brown beneath chin; upper lip below eye mottled; no dark cheek patch; hind limbs not distinctly barred with dark bands.

Material.—One hundred and fifty specimens in the Museum of Vertebrate Zoology from the following localities in the Sierra Nevada of California. Tulare County: Taylor Meadow, 7000 feet altitude (nos. 3000–3010); Manter Meadow, 7000 feet (3012, 3013); Jackass Meadow, 7750 feet (nos. 3014–3019); Monache Meadow (nos. 3020-3033); vicinity of Ramshaw Meadow, 8800 feet (nos. 3034–3035); Whitney Meadows, 9800 feet (nos. 3036–3053); Whitney Creek, 11,500 feet (no. 3055); Inyo County: Matlack Lake (as above); Yosemite National Park: vicinity of Peregoy Meadow, 7000–7300 feet (nos. 5781–5788, 5800); vicinity of Porcupine Flat, 8100 feet (nos. 5774, 5775, 5789, 5803, 5804); Tenaya Lake (no. 5790); Tuolumne Meadows, 8600 feet (no. 5801); vicinity of Young Lake, 10,000 feet(nos. 5791-5796); head of Lyell Cañon, 9700–10,500 feet (nos. 5797–5799, 5802); Vogelsang Pass, 10,450 feet (no. 6015); Vogelsang and Evelyn lakes, 10,350 feet (nos. 5962–5986, 5988–6014, 6016–6027); and Sunrise Creek, 7300 feet (no. 5987).

Variations.—Three specimens from the southern Sierra Nevada and two from Young Lake, Tuolumne County, show faint traces of a lighter patch across the anterior part of the head, as in *R. b. boylii.* Nearly all the frogs from Whitney Meadows have the dorso-lateral folds unusually well developed. The dorsal color pattern varies widely. Occasionally the back is uniformly reddish-, brownish-, or blackish-yellow; more rarely it is evenly marbled with dark brown upon a dark yellow background with or without indefinite lighter spots; more frequently the darker markings remain as indefinite patches or as distinct black spots, thus approaching the pattern of *R. pretiosa.* The outline of the head viewed from above is either rounded as in the type or pointed as in *boylii;* in some specimens it is as wide as in the narrowest *boylii.*

This seems to be the subspecies of *boylii* which approaches most closely to the species *pretiosa.* A few specimens can be found in which the vomerine teeth are confined to the ends of slight swellings on the vomerine ridges, much as in *pretiosa* (see fig. 1); the outline of the head is in some specimens the same as in *pretiosa,* and the short hind leg carries the resemblance still farther. The dorsal color pattern, while usually quite different from that in *pretiosa,* suggests the latter in an occasional individual. I am inclined to place *sierrae* with *boylii* on account of the character of the vomerine teeth in most of the specimens (see figs. 1–3), the usual absence of distinct dorso-lateral folds, the mottling of the upper lip, the lack of red in the coloration of the

1 2 3

Fig. 1.—Inside of mouth of *Rana pretiosa pretiosa,* no. 5566, Mus. Vert. Zool.; note vomerine teeth restricted to inner, expanded ends of oblique ridges, and the large maxillary and premaxillary teeth.

Fig. 2.—Inside of mouth of *Rana boylii sierrae,* no. 3734, Mus. Vert. Zool.; note resemblance of teeth to those of *R. b. boylii.*

Fig. 3.—Inside of mouth of *Rana boylii boylii,* no. 6100, Mus. Vert. Zool.; note vomerine teeth on whole length of oblique ridges and small teeth of upper jaw. All × 1½.

under parts, and the suggestion of a white, anterior head-patch in seven or eight out of the 150 specimens examined.

Remarks.—This is the only species of frog known to occur above 7000 feet altitude in the Sierra Nevada. Its range is the entire southern half of those mountains, at least from the Yosemite National Park on the north to southern Tulare County on the south. It inhabits meadows, streams and lakes from about 7000 to 10,500 feet in the Yosemite Park, and to 11,500 feet near Mount Whitney. In some of the lakes it was found in great numbers, appearing as soon as the ice had melted in late June. The tadpoles were at this time of large size and must have been hatched from eggs of a laying not more recent than the previous year.

The specimen selected as the type is referred to by Mr. Harry S. Swarth in his field notes as having been the object of an attack by a Clarke Crow. "The crow would peck at the frog and the latter would squeal and puff himself out to twice his normal size. It was his cries that attracted me."

KEY TO CALIFORNIA FROGS

1. Vomerine teeth rudimentary, on two oblique ridges between the nares (see figs. 2, 3); tympanic region not darker than rest of head; fold along upper lip colored like rest of body, mottled or dark; red never present in coloration ....*Rana boylii* and subspecies.

 2. When hind leg is brought forward along body, inside angle of bent tarsus and tibia reaching at least to nares and often beyond end of snout; tympanum covered with many hispid points.

  3. A light patch on top of head; darker area crossing the posterior half of each upper eyelid merging insensibly into dorsal color behind; body-length under 70 millimeters ....*Rana boylii boylii* Baird.

  3′. No light patch on top of head; darker areas crossing posterior half of each upper eyelid, when present, contrasting with dorsal coloration; body-length reaching 81 millimeters ....*Rana boylii muscosa* Camp.

 2′. When leg is brought forward, inside angle of bent tarsus seldom reaching beyond nares; tympanum smooth or with but a few hispid points; no light patch on top of head; body-length reaching 73 millimeters ....*Rana boylii sierrae* Camp.

1′. Vomerine teeth large, in clusters on ends of indistinct oblique ridges inside nares (see fig. 1); tympanic region darker than rest of head (except often in *pretiosa*); fold along upper lip usually white or lighter than rest of head; red often present in coloration.

 4. When leg is brought forward along body, inside angle of bent tarsus reaching to eye or nares, never beyond.

  5. Back and top of head, set with inky, black spots; a small outer metatarsal tubercle ....*Rana pretiosa pretiosa* Baird and Girard.

  5′. Back, and top of head, with dark spots not so black as in *pretiosa;* no outer metatarsal tubercle ....*Rana pretiosa luteiventris* Thompson.

 4′. Inside angle of bent tarsus and tibia, when brought forward, reaching to or beyond nares; back and top of head without inky spots ....*Rana aurora* and subspecies.

  6. Dorso-lateral folds indistinct; skin very smooth and thin; dorsal surfaces unspotted or with small dots; size medium; total length reaching 80 millimeters ....*Rana aurora aurora* Baird and Girard.

  6′. Dorso-lateral folds prominent; skin thick and often slightly roughened; dorsal surfaces with regularly placed, light centered spots; size large; total length reaching 100 millimeters ....*Rana aurora draytonii* Baird and Girard.

Notes on the Distribution of Western Frogs

Rana pretiosa pretiosa is known from nearly throughout Washington and Oregon, north into Canada, east into Montana, Wyoming, and northern Utah, and south into extreme northern California.

Rana pretiosa luteiventris, a form recently described by Thompson (1913, pp. 53–55) from Humboldt and Maggie valleys, Eureka and Elko counties, Nevada, seems to be represented in the Museum of Vertebrate Zoology by two specimens (nos. 2098, 2099), collected by Dr. H. C. Bryant at Alturas, Modoc County, California.

Rana aurora aurora, described from Puget Sound, is known to the present writer from the Willamette Valley, Oregon, and from Eureka, Humboldt County, California, on the basis of specimens in the Museum of Vertebrate Zoology. Specimens from Mendocino City, on the coast of Mendocino County, California, are intergrades between *aurora* and *draytonii.*

Rana aurora draytonii ranges north from the San Pedro Martir Mountains, in Lower California, to Gualala, Mendocino County, California (as indicated by material in the Museum of Vertebrate Zoology), and east from the coast to the foothills of the Sierra Nevada and into the mountains of southern California up to an altitude of 4000 feet.

Transmitted October 28, 1916.

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A DISTRIBUTIONAL LIST OF THE AMPHIBIANS AND REPTILES OF CALIFORNIA

BY

JOSEPH GRINNELL AND CHARLES LEWIS CAMP

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(Contribution from the Museum of Vertebrate Zoology of the University of California)

The present paper deals with the systematic status and geographic distribution of the amphibians and reptiles known to occur within the present boundaries of the state of California. By including data bearing on geographic distribution, and by placing the emphasis on this rather than on the systematic phase of the subject, we hope to forestall the criticism which is sometimes directed at a purely nominal list. Restriction of the area treated to the limits of California has made possible critical study of most of the species included. We believe that such a summary as is here presented is worth while at the present time, in that it will accelerate inquiry in this field and serve to direct the attention of workers towards the more conspicuous gaps in our common knowledge.

The past two decades have witnessed the accumulation of much information of the sort herewith presented. Many collections have been made and a considerable amount of literature has appeared in widely scattered places. Study of the large collection of newly gathered specimens (6160) with full data now contained in the Museum of Vertebrate Zoology and a critical review of the literature to date form the basis of the present contribution.

The writers have followed Stejneger (*Herpetology of Japan and Adjacent Territory*[1]) for the systematic arrangement used, and also for most of the names of groups higher than genera. Where there

[1] U. S. Nat. Mus. Bull., 58, 1907, pp. xx + 577, 35 pls., 409 figs. in text.

has been question as to the applicability of specific names our decision has been based on a precise interpretation of the rules of nomenclature and, where possible, upon recourse to type specimens. The determination of species has been made at first hand, chiefly by the junior author, on the basis of the collections and literature at hand, with the exception of one genus: for the garter snakes (*Thamnophis*) we have followed Ruthven (*Variations and Genetic Relationships of the Garter Snakes*[2]).

The vernacular names chosen have been selected primarily upon the grounds of previous use; sometimes fitness has been a factor in their selection. The type locality of each species has been stated as accurately as possible. Where the original statement of it was vague we have attempted to supply a more exact designation. In some cases this was not possible, and in a few others the type locality could not be determined at all. Under "synonyms" and "common names" are included all names, both scientific and vernacular, other than the accepted ones, which have been applied to the species *as occurring in California*. Where the term "part" is used it means that the name which it follows has been used for another *Californian* species. Where a name now considered synonymous with an accepted name was based on a specimen from California, the full citation and the type locality are given; lack of space prevents giving the citations for all synonyms. However, there is an index to all of these on file in the Museum of Vertebrate Zoology, to which persons interested in following the subject farther are free to appeal. Needless to say, all of the specimens in the Museum of Vertebrate Zoology are freely accessible for reexamination by any student who may wish to verify our determinations.

Besides the species and subspecies given regular place in the present summary, all of which are known definitely to inhabit the state, there are sixty or more species accredited to California on grounds which do not seem to us satisfactory. Where possible we have assigned these species to positions in the synonymy of forms in good standing, but a number of them have had to be stricken entirely from the list as indeterminable. We have not deemed it desirable to list these numerous doubtful names here.

The statements of range for the several species involve the use of three modes in which the distribution of vertebrate animals has been designated. The first and more detailed statement is of a purely

[2] U. S. Nat. Mus. Bull., **61**, 1908, pp. xii + 201, frontispiece pl., 82 figs. in text.

geographic nature. Here, where the data permit, series of record stations are given so as to outline roughly the range with regard to political boundaries and towns, or to features of the topography and drainage. Extreme points of occurrence on the north, east, south, and west are thus given, sometimes several in each direction where a long line is to be covered. For each of these the source of the record is mentioned. This may be in published literature, in some one's unpublished notes, or from specimens in this museum.

Secondly, where practicable, the life-zone in which the species occurs is given, for the purpose of bringing this paper into concordance with others on the distribution of California vertebrates. Thirdly, the habitat or associational restriction of the species is given. For an explanation of these two latter modes of distributional designation the reader is referred to a paper by the senior author (Grinnell, *A Distributional List of the Birds of California*[3]).

The maps offered herewith serve to show the ranges of many of the species of amphibians and reptiles in California from a purely geographic standpoint. Stations of known occurrence are indicated by appropriate signs, and with some of the species we have ventured to indicate the outlines of the inferred ranges. By comparison of these maps one with another and with maps showing the distribution of birds and mammals in this state, a number of remarkable coincidences in distribution will be observed. It must be that similar or, possibly, the same factors operate to limit the distribution of such widely different kinds of animals. Much yet needs to be realized in the improvement of means of expressing the facts of animal distribution; only a mere beginning has been made in systematizing such knowledge as is already at hand. The meaning of distributional limitation is one of the most fascinating subjects claiming the attention of the field biologist. Really satisfactory inquiry into the underlying causes must await the accumulation and assortment of vastly more data than are here presented for reptiles and amphibians, and the same degree of exhaustiveness must be applied to many different areas.

Most of the heretofore unpublished data used in the present paper have been gathered during the past eight years for the Museum of Vertebrate Zoology by various field parties working in its employ. For the expense of bringing together and caring for the collections of reptiles and amphibians now accessible in this museum, workers in herpetology are indebted to Miss Annie M. Alexander. For the

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[3] Pacific Coast Avifauna, **11**, 1915, 217 pp., 3 pls.

privilege of examining California specimens in the United States National Museum and for help in many questions of nomenclature the present authors are indebted to Dr. Leonhard Stejneger, head curator of biology in that institution. For help in the location of certain geographic names and for critical assistance in proof-reading we owe acknowledgment to Mr. Tracy I. Storer, of the staff of the Museum of Vertebrate Zoology.

According to the present enumeration, there are represented in the fauna of California one hundred and sixteen species and subspecies of amphibians and reptiles. These fall into forty-six genera, twenty-two families, and four orders.

Class **AMPHIBIA**

Order CAUDATA

Suborder MUTABILIA

Superfamily SALAMANDROIDEAE

Family SALAMANDRIDAE

Notophthalmus torosus (Rathke)

Pacific Coast Newt

Original Description.—*Triton torosus* Rathke, *in* Eschscholtz, Zoologischer Atlas, pt. 5, 1833, pp. 12–14, pl. 21, fig. 15.

Type Locality.—Central California near coast, either at San Francisco or between San Rafael, Marin County, and Fort Ross, Sonoma County (see Kotzebue's "New Voyage").

Synonyms.—*Salamandra Beecheyi* Gray, Zool. Beechey's Voyage, 1839, p. 99, pl. 31, fig. 3 (type from Monterey, Monterey County); "*Triton Ermani* Wiegmann, *in* Erman's Reise um die Erde, Atlas, 1835, p. 24" [see Wiegmann's Archive für Naturgeschichte, 2 Jahrg., **2**, 1836, pp. 163, 250] (type from California); *Diemictylus torosus; Taricha torosa; Molge torosa; Cynops torosus; Taricha laevis* Baird and Girard, Proc. Acad. Nat. Sci. Phila., **6**, 1853, p. 302 (type from San Francisco); *Triton laevis; Amblystoma rubrum* Reid, History of Pasadena [California], 1895, p. 600 (type [by inference] from near Pasadena); [?] *Pleurodeles californiae;* [?] *Triton tereticauda* Eschscholtz, Zoologischer Atlas, pt. 5, 1833, p. 14 (type from Fort Ross, Sonoma County); *Aneides lugubris,* part.

Common Names.—Western Newt; Warty Salamander; Water-dog; Capt. Beechey's Salamander; Pacific Water-lizard; California Newt; Sad-colored Anaides, part.

RANGE.—Restricted to Pacific drainage; most abundant west of first coast divides. Found locally in Sacramento and San Joaquin valleys, and in the central Sierra Nevada to 5500 feet altitude, as near Cisco, Placer County (Mus. Vert. Zool.). Southernmost station,

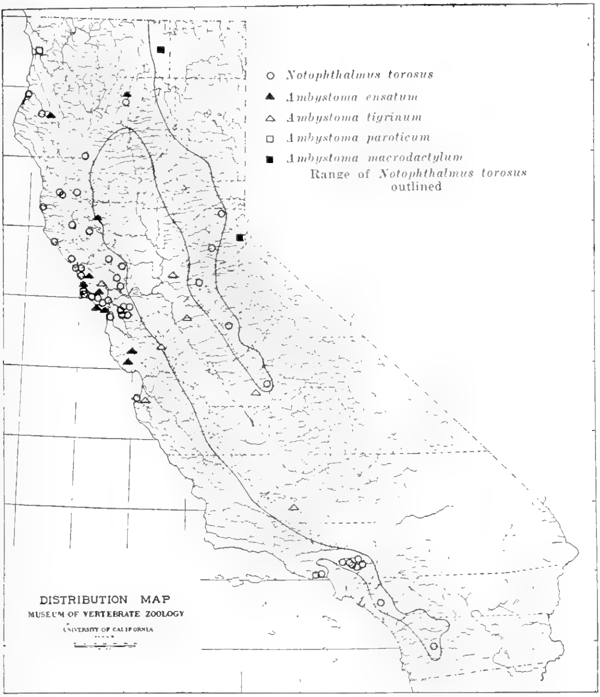

Fig. 1. Distribution of Salamanders (*Notophthalmus* and *Ambystoma*) in California.

San Diego River, San Diego County (Orcutt, West Amer. Scientist, **1**, 1885, p. 5). Occupies Upper Sonoran and Transition life-zones, occasionally entering Canadian. Inhabits vicinity of streams and ponds; in fall and winter the females live under rocks and logs, while the males often remain in the water. (See fig. 1.)

Family PLETHODONTIDAE

Subfamily Spelerpinae

Spelerpes platycephalus Camp

Mount Lyell Salamander

Original Description.—*Spelerpes platycephalus* Camp, Univ. Calif. Publ. Zool., **17**, September 18, 1916, pp. 11–14, 5 figs.

Type Locality.—Head of Lyell Cañon, 10,800 feet altitude, Yosemite National Park, Tuolumne County, California.

Range.—Known only from the type locality, as above. This is at the upper edge of the Hudsonian life-zone. The two specimens were taken in a patch of heather among the rocks where water issued from beneath surrounding snowbanks. (See fig. 2.)

Subfamily Plethodontinae

Plethodon eschscholtzii (Gray)

Oregon Salamander

Original Description.—*Ensatina Eschscholtzii* Gray, Cat. Amphibia Brit. Mus., pt. 2, 1850, p. 48.

Type Locality.—California: Monterey (*fide* Boulenger, Cat. Batrachia Brit. Mus., ed. 2, 1882, p. 55).

Synonyms.—*Plethodon ensatus; Plethodon oregonensis.*

Common Names.—Oregon Triton; Oregon Plethodon.

Range.—Coast region. Has been taken south as far as Forest Home, 5200 feet altitude, in the San Bernardino Mountains (no. 4890, Mus. Vert. Zool.). Only one station interiorly from the coast belt: [probably mountains near] Fresno (nos. 17,650–17,652, U. S. Nat. Mus.). Occurs in Transition and Upper Sonoran life-zones. Inhabits damp, shady places in forests and heavy brush; often found beneath masses of decaying vegetation and in holes in the earth. (See fig. 2.)

Plethodon croceater Cope

Yellow-spotted Salamander

Original Description.—*Plethodon croceater* Cope, Proc. Acad. Nat. Sci. Phila., 1867 [1868], pp. 210–211.

Type Locality.—Fort Tejon, Kern County, California. (What is probably the type is contained in the collection of the Department of Zoology, University of California.)

SYNONYM.—[?] *Plethodon flavipunctatus* Strauch, Mem. Acad. Imper. Sci. St. Petersb., ser. 7, **16**, no. 4, 1870, p. 71 (type from "New Albion," California) [see Van Denburgh, Proc. Calif. Acad. Sci., ser. 4, **6**, 1916, p. 221].

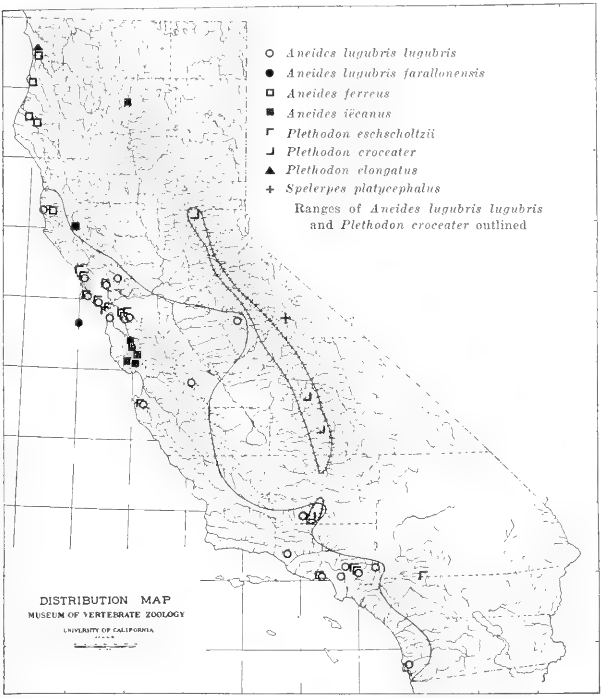

Fig. 2. Distribution of Salamanders (*Plethodon*, *Spelerpes*, and *Aneides*) in California.

COMMON NAMES.—Cape St. Lucas Triton; Yellow-spotted Lizard.

RANGE.—Sierra Nevada Mountains (Van Denburgh, *loc. cit.*). Definite stations of occurrence are: Mud Spring, 6300 feet altitude, 4 miles southwest of Nelson, Tulare County (3 specimens, Mus. Vert. Zool.); Grant Forest, Sequoia National Park, Tulare County (2 specimens, Univ. Calif. Dept. Zool.); Alta, 3600 feet altitude, Placer County (1 specimen, Univ. Calif. Dept. Zool.); Fort Tejon (as above). Occurs within the Transition life-zone. Inhabits damp places in forests. (See fig. 2.)

Plethodon elongatus Van Denburgh

Del Norte Salamander

Original Description.—*Plethodon elongatus* Van Denburgh, Proc. Calif. Acad. Sci., ser. 4, **6**, May 12, 1916, pp. 216–218.

Type Locality.—Requa, Del Norte County, California.

Range.—Known only from the type locality, as above. (See fig. 2.)

Aneides lugubris lugubris (Hallowell)

Arboreal Salamander

Original Description.—*Salamandra lugubris* Hallowell, Proc. Acad. Nat. Sci. Phila., **4**, 1848 [1850], p. 126.

Type Locality.—Monterey, California.

Synonyms.—*Anaides lugubris,* part; *Ambystoma punctulatum* Gray, Cat. Batr. Caud. in Brit. Mus., 1850, p. 37 (type from Monterey); *Ambystoma punctatum,* part; *Taricha lugubris; Autodax lugubris,* part; *Plethodon crassulus* Cope, Proc. Amer. Philos. Soc., **23,** 1886, pp. 521–522 (type from California) [Van Denburgh (Proc. Calif. Acad. Sci., ser. 4, **6,** 1916, pp. 219–220) regards this name as a synonym of *Plethodon intermedius,* and doubts that the type really came from California].

Common Names.—California Land Salamander; Sad-colored Anaides, part; Spotted Autodax; Mournful Salamander; Speckled Salamander.

Range.—Abundant in the inner coast region. Occurs north as far as Mendocino City, Mendocino County (Mus. Vert. Zool.). The two isolated interior stations are: 3 miles northeast of Coulterville, 3100 feet altitude, Mariposa County, and Los Baños, Merced County (Mus. Vert. Zool.). Southeasternmost occurrence within the state: San Diego County (U. S. Nat. Mus.; also see Miller, Amer. Nat., **40,** 1906, pp. 741–742). Occurs chiefly in the Upper Sonoran life-zone, though extending into adjacent Transition and into Lower Sonoran. Lives in hollows of oak trees and also on the ground beneath stones and logs, as a rule in oak woods. (See fig. 2.)

Aneides lugubris farallonensis (Van Denburgh)

Farallon Salamander

ORIGINAL DESCRIPTION.—*Autodax lugubris farallonensis* Van Denburgh, Proc. Calif. Acad. Sci., ser. 3, zool., **4**, June 15, 1905, pp. 5–6, pl. 2.

TYPE LOCALITY.—South Farallon Island, San Francisco County, California.

SYNONYMS.—*Anaides lugubris*, part; *Autodax lugubris*, part.

RANGE.—Known only from South Farallon Island. Found under rocks. (See fig. 2.)

Aneides ferreus (Cope)

Rusty Salamander

ORIGINAL DESCRIPTION.—*Anaides ferreus* Cope, Proc. Acad. Nat. Sci. Phila., 1869, pp. 109–110.

TYPE LOCALITY.—Fort Umpqua, Douglas County, Oregon.

RANGE.—Extreme northern humid coast belt. Recorded only from the following localities (Van Denburgh, Proc. Calif. Acad. Sci., ser. 4, **6**, 1916, p. 216): Requa, Del Norte County; Alton, Trinidad, and Carlotta, Humboldt County; Comptche, Mendocino County. These localities lie in the Transition life-zone. Specimens at Requa were taken from the rotten wood of a dead tree, twenty feet above the ground. (See fig. 2.)

Aneides iëcanus (Cope)

Shasta Salamander

ORIGINAL DESCRIPTION.—*Plethodon iëcanus* Cope, Proc. Acad. Nat. Sci. Phila., 1883, pp. 24–25.

TYPE LOCALITY.—Baird, Shasta County, California.

SYNONYMS.—*Anaides iëcanus; Autodax iëcanus.*

COMMON NAME.—Black Salamander.

RANGE.—Known only from west-central and northern California, the following being the record stations known to date: Baird and McCloud River, Shasta County (Townsend, Proc. U. S. Nat. Mus., **10**, 1887, pp. 240–241); Humboldt County (Univ. Calif. Dept. Zool.); Ukiah, Mendocino County (Mus. Vert. Zool.); Los Gatos and Stevens Creek, Santa Clara County, and Glenwood and Boulder, Santa Cruz

County (Van Denburgh, Proc. Calif. Acad. Sci., ser. 2, **5**, 1895, pp. 776–778); Mountain View, Santa Clara County (no. 21170, U. S. Nat. Mus.). Occurs mainly within the Transition life-zone. Lives in recesses in the ground and beneath logs, stones, and boards, often in the vicinity of running water. (See fig. 2.)

Batrachoseps pacificus (Cope)

Island Salamander

Original Description.—*Hemidactylium pacificum* Cope, Proc. Acad. Nat. Sci. Phila., 1865, pp. 195–196.

Type Locality.—Santa Barbara, California [doubtless one of the Channel Islands near Santa Barbara: Van Denburgh, Proc. Calif. Acad. Sci., ser. 3, zool., **4**, 1905, p. 7].

Common Name.—Pacific Lizard.

Range.—Known only from San Miguel, Santa Rosa, and Santa Cruz islands, off the coast of southern California (Van Denburgh, Proc. Calif. Acad. Sci., ser. 4, **4**, 1914, pp. 134, 135). (See fig. 3.)

Batrachoseps major Camp

Garden Salamander

Original Description.—*Batrachoseps major* Camp, Univ. Calif. Publ. Zool., **12**, April 2, 1915, pp. 327–330.

Type Locality.—Sierra Madre (the town), 1000 feet altitude, Los Angeles County, California.

Synonym.—[?] *Batrachoseps attenuatus*, part.

Range.—Known only from the Pacific slope of southern California, where recorded definitely only from Pasadena, and from the type locality, as above. Occurs within the Lower Sonoran life-zone. In the rainy season lives at the surface of the ground beneath boards and stones; in the dry season retreats into the earth. (See fig. 3.)

Batrachoseps attenuatus (Eschscholtz)

Slender Salamander

Original Description.—*Salamandrina attenuata* Eschscholtz, Zoologischer Atlas, pt. 5, 1833, pp. 1–6, pl. 21.

Type Locality.—Central California near coast, either at San Francisco or between San Rafael, Marin County, and Fort Ross, Sonoma County.

Synonyms.—*Salamandra attenuata;* [?] *Batrachoseps pacificus,* part; *Batrachoseps nigriventris* Cope, Proc. Acad. Nat. Sci. Phila., 1869, p. 98 (type from Fort Tejon, Kern County).

Common Names.—Slender Lizard; Black-bellied Lizard.

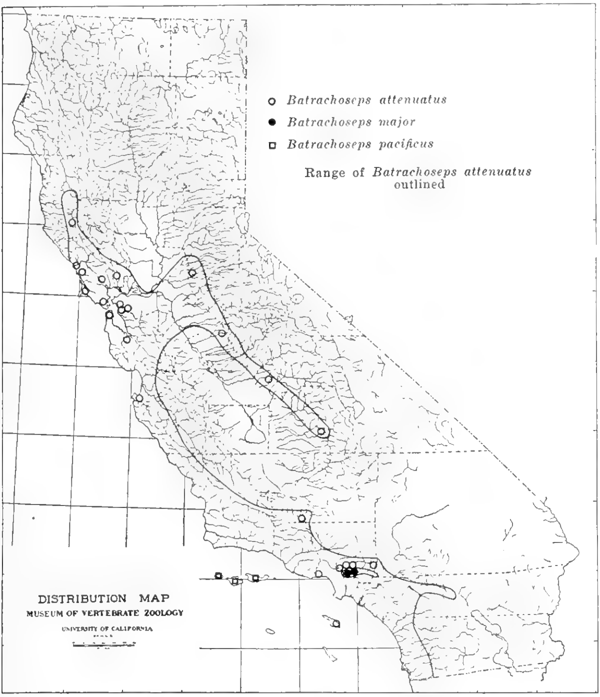

Fig. 3. Distribution of Slender Salamanders (*Batrachoseps*) in California.

Range.—Coast district from Ukiah, Mendocino County, south at least to mountains immediately north of Claremont, Los Angeles County; occurs also along the foothills of the central Sierra Nevada, north to Eldorado County (U. S. Nat. Mus.) and southeast to three miles south of Nelson, Tulare County (Mus. Vert. Zool.), and on Santa Catalina Island (Van Denburgh, Proc. Calif. Acad. Sci., ser. 3, zool.,

4, 1905, p. 16). Occurs chiefly within the Upper Sonoran life-zone, though entering Transition and upper edge of Lower Sonoran locally. Found in rotten logs, in damp masses of dead vegetation, beneath rocks on shaded slopes, and in rodent burrows in the ground. (See fig. 3.)

Family AMBYSTOMIDAE

Ambystoma tigrinum (Green)

Tiger Salamander

Original Description.—*Salamandra tigrina* Green, Journ. Acad. Nat. Sci. Phila., **5**, 1825, pp. 116–118, pl. 25, fig. 7.

Type Locality.—Near Moorestown, New Jersey.

Synonyms.—*Ambystoma tigrinum,* part; *Ambyostoma californiense* Gray, Proc. Zool. Soc. Lond., **21**, 1853, p. 11, pl. 7 (type from Monterey); *Ambystoma tigrinum californiense; Ambystoma mavortium californiense; Ambystoma mavortium;* [?] *Ambystoma ingens;* [?] *Heterotriton ingens; Amblystoma californicum.*

Common Names.—California Axolotl; California Salamander.

Range.—The west-central part of the state, where known from the following localities: Galt, Sacramento County; Ripon, San Joaquin County; and Mount Hamilton, Santa Clara County (Storer, Copeia, no. 24, November, 1915, p. 56); Monterey, Monterey County (as above); Fresno, Fresno County; Fort Tejon, Kern County; and Petaluma, Sonoma County (Cope, U. S. Nat. Mus. Bull., **34**, 1889, pp. 85–86). These localities lie in the Upper Sonoran life-zone, save for Fresno, which is in the Lower Sonoran, and Monterey, which is in Transition. Inhabits burrows of rodents in open country. (See fig. 1.)

Ambystoma macrodactylum Baird

Long-toed Salamander

Original Description.—*Ambystoma macrodactyla* Baird, Journ. Acad. Nat. Sci. Phila., ser. 2, **1**, 1850, p. 292.

Type Locality.—Astoria, Oregon.

Common Name.—Flat-footed Salamander.

Range.—High northeastern section of the state, with record stations as follows: "California" (Boulenger, Cat. Batr. Brit. Mus., ed. 2, 1882, p. 48); near Medicine Lake, 6500 feet altitude, Siskiyou

County (Univ. Calif. Dept. Zool.); near Fallen Leaf Lake, Eldorado County (Van Denburgh, Proc. Calif. Acad. Sci., ser. 4, **6**, 1916, p. 215). Life-zone, Transition. (See fig. 1.)

Ambystoma ensatum (Eschscholtz)

Marbled Salamander

Original Description.—*Triton ensatus* Eschscholtz, Zoologischer Atlas, pt. 5, 1833, pp. 6–12, pl. 22.

Type Locality.—Central California near coast, possibly near Fort Ross, Sonoma County.

Synonyms.—*Chondrotus tenebrosus; Amblystoma tenebrosum; Dicamptodon ensatus; Xiphonura tenebrosa; Chondrotus lugubris.*

Common Name.—Oregon Salamander, part.

Range.—Chiefly the humid coast belt, occurring south as far as six miles north of Boulder, Santa Cruz County (Camp, MS). Recorded also from McCloud River, Shasta County (Townsend, Proc. U. S. Nat. Mus., **10**, 1887, p. 240), and Allen Springs, Lake County (Univ. Calif. Dept. Zool.). Occupies the Transition life-zone. Inhabits tracts of forest and heavy brush; lives in streams, or under rocks and in holes in wet earth. (See fig. 1.)

Ambystoma paroticum Baird

British Columbia Salamander

Original Description.—*Amblystoma paroticum* Baird, Proc. Acad. Nat. Sci. Phila., 1867 [1868], pp. 200–201.

Type Locality.—Chiloweyuck, Washington Territory [= Chilliwack Lake, British Columbia].

Common Name.—Vancouver's Salamander.

Range.—Recorded only from Requa, Del Norte County (Van Denburgh, Proc. Calif. Acad. Sci., ser. 4, **6**, 1916, p. 216). Found in wet earth under a stump. (See fig. 1.)

Order SALIENTIA

Suborder COSTATA

Family DISCOGLOSSIDAE

Ascaphus truei Stejneger

American Bell-toad

Original Description.—*Ascaphus truei* Stejneger, Proc. U. S. Nat. Mus., **21**, June 20, 1899, pp. 899–901, pl. 89.

Type Locality.—Humptulips, Chehalis County, Washington.

Range.—One capture: Northwest slope Craggy Peak, elevation 5000 feet, Siskiyou Mountains, Siskiyou County (no. 45362, U. S. Nat. Mus.).

Suborder LINGUATA

Family PELOBATIDAE

Scaphiopus hammondii hammondii Baird

Western Spadefoot

Original Description.—*Scaphiopus hammondii* Baird, Pac. R. R. Rep., **10**, 1859, Abbot's report, pt. 4, no. 4, p. 12, pl. 28 (figs. 2*a*, 2*b*, 2*c*, 2*d*).

Type Locality.—Fort Reading [near Redding, in Shasta County], California.

Synonyms.—*Spea hammondii; Spea stagnalis.*

Common Names.—Hammond's Spea; New Mexican Spea; Hammond's Spadefoot.

Range.—Semi-arid portions of the state both east and west of the Sierra Nevada, from San Diego (Cooper, *in* Cronise, Nat. Wealth Calif., 1868, p. 486) to Fort Reading, as above. Present records include: Los Angeles (Univ. Calif. Dept. Zool.) and Sierra Madre (Mus. Vert. Zool.), Los Angeles County; Santa Barbara (Yarrow and Henshaw, Ann. Rep. U. S. Engineers, 1878, p. 1631); Olancha, Inyo County (Stejneger, N. Amer. Fauna, **7**, 1893, p. 222); Benton and Mono Lake, Mono County (Mus. Vert. Zool.); Lane's Bridge, Fresno County (Mus. Vert. Zool.); and Simmler, San Luis Obispo County (Mus. Vert. Zool.). Occurs chiefly in the Lower Sonoran life-zone, but extends also into Upper Sonoran. Inhabits open country where soil is of a nature to permit burrowing to safe depths during dry periods.

Family BUFONIDAE

Bufo cognatus cognatus Say

Great Plains Toad

Original Description.—*Bufo cognatus* Say, *in* Long's Expedition to Rocky Mountains, **2**, 1823, p. 190, footnote.

Type Locality.—Arkansas River [in Colorado, probably between present site of La Junta and the Colorado-Kansas boundary].

Range.—Only along the Colorado River north to Needles, San Bernardino County, and in the Salton Basin northwest to Mecca, Riverside County (Mus. Vert. Zool.). Life-zone, Lower Sonoran. Inhabits overflow bottom-lands and irrigated districts. (See fig. 4.)

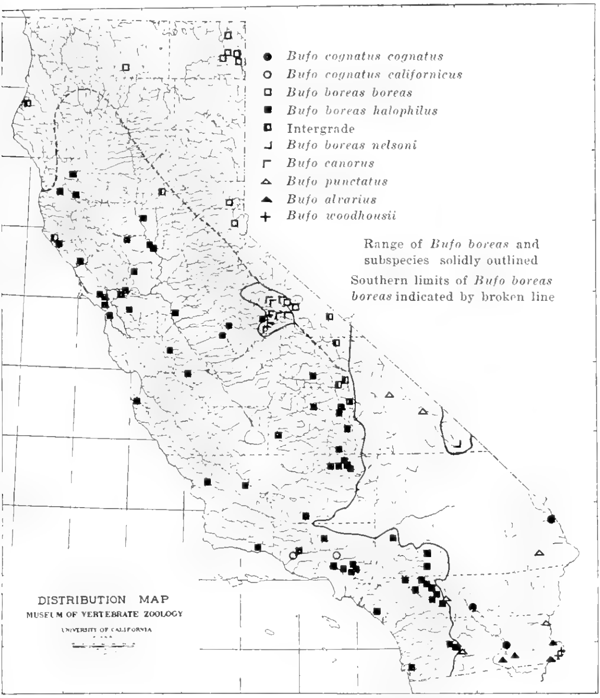

Fig. 4. Distribution of Toads (*Bufo*) in California.

Bufo cognatus californicus Camp

Arroyo Toad

Original Description.—*Bufo cognatus californicus* Camp, Univ. Calif. Publ. Zool., **12**, April 2, 1915, pp. 331–334.

Type Locality.—Santa Paula, Ventura County, California.

Range.—Known only from the type locality, as above, and from the Tujunga Wash, near Sunland, Los Angeles County, California (Camp, *loc. cit.*). Both these places lie in the Lower Sonoran life-zone. Found in vicinity of dry washes. (See fig. 4.)

Bufo woodhousii Girard

Rocky Mountain Toad

Original Description.—*Bufo woodhousii* Girard, Proc. Acad. Nat. Sci. Phila., **7**, 1854, p. 86 (this name to replace *Bufo dorsalis* of Hallowell, Proc. Acad. Nat. Sci. Phila., **6**, 1852, pp. 181–182).

Type Locality.—New Mexico [= Arizona; type no. 2531 in U. S. Nat. Mus., labeled "Calif. Mountains, Mexico," which equals San Francisco Mountains, Arizona: see Stejneger, N. Amer. Fauna, **3**, 1890, pp. 116–117].

Synonyms.—*Bufo lentiginosus americanus; Bufo lentiginosus woodhousii.*

Common Names.—Woodhouse's Toad; American Toad.

Range.—Along the Colorado River (Cooper, *in* Cronise, Nat. Wealth Calif., 1868, p. 486). Stations of recent capture are: near Potholes and 5 miles northeast of Yuma, Imperial County (Mus. Vert. Zool.). Both stations are on the bottom-lands and in the Lower Sonoran life-zone. (See fig. 4.)

Bufo boreas halophilus Baird and Girard

California Toad

Original Description.—*Bufo halophila* Baird and Girard, Proc. Acad. Nat. Sci. Phila., **6**, 1853, p. 301.

Type Locality.—Benicia, Solano County, California.

Synonyms.—*Bufo boreas*, part; *Bufo chilensis; Bufo columbiensis*, part; *Bufo columbiensis halophilus; Bufo boreas nelsoni*, part.

Common Names.—Baird's Toad, part; Common Toad; Salt-marsh Frog.

Range.—Throughout both the coast region and the interior valleys, north typically to Gualala River, Sonoma County, to Oroville, Butte County, and to vicinity of Independence, Inyo County; east, centrally, into Owens Valley, and to Antelope Valley, Los Angeles County, and Victorville, San Bernardino County; east at the south to Vallecito and La Puerta, San Diego County (Mus. Vert. Zool.). Southernmost station, San Diego (Yarrow, U. S. Nat. Mus. Bull., **24**, 1882, pp. 23, 162). Absent from deserts bordering Colorado River. Occurs in all life-zones below upper edge of Hudsonian. Inhabits open valleys and, rarely, wooded areas; in the high mountains inhabits wet meadows and lake shores; lives during the day in gopher and ground-squirrel burrows and under rocks. (See fig. 4.)

Bufo boreas boreas Baird and Girard

Northwestern Toad

Original Description.—*Bufo boreas* Baird and Girard, Proc. Acad. Nat. Sci. Phila., **6**, 1852, pp. 174–175.

Type Locality.—Columbia River and Puget Sound.

Synonyms.—*Bufo columbiensis,* part; *Bufo halophilus,* part; *Bufo microscaphus.*

Common Names.—Baird's Toad, part; Small-spaded Toad.

Range.—Northern portion of the state, south to Eureka, Humboldt County, to Sisson, Siskiyou County, and to Mono County (Mus. Vert. Zool.). From these localities and others adjacent, specimens show intergradation towards *B. b. halophilus.* Occurs in the Transition and Upper Sonoran life-zones. Lives in tules about lake shores, along streams, and in mountain meadows. (See fig. 4.)

Bufo boreas nelsoni Stejneger

Nevada Toad

Original Description.—*Bufo boreas nelsoni* Stejneger, N. Amer. Fauna, **7**, May 31, 1893, pp. 220–221, pl. 3, figs. 4*a*, 4*b*.

Type Locality.—Oasis Valley, Nye County, Nevada.

Range.—Eastern Inyo region. Recorded from Resting Springs, Inyo County (Stejneger, *loc. cit.*). Life-zone, Lower Sonoran. (See fig. 4.)

Bufo canorus Camp

Yosemite Park Toad

Original Description.—*Bufo canorus* Camp, Univ. Calif. Publ. Zool., **17**, November 17, 1916, pp. 59–62, figs. 1–4.

Type Locality.—Porcupine Flat, 8100 feet altitude, Yosemite National Park, Mariposa County, California.

Range.—High central Sierra Nevada, 7000 to 11,000 feet altitude, almost altogether within the limits of the Yosemite National Park

(Mus. Vert. Zool.). Occupies the Canadian and Hudsonian life-zones, extending even into Alpine-Arctic. Inhabits vicinity of meadows and the margins of streams and lakes. (See fig. 4.)

Bufo punctatus Baird and Girard

Spotted Toad

Original Description.—*Bufo punctatus* Baird and Girard, Proc. Acad. Nat. Sci. Phila., **6**, 1852, p. 173.

Type Locality.—Rio San Pedro of the Rio Grande del Norte (in Texas?).

Synonym.—*Bufo beldingi.*

Range.—Colorado desert, west to Vallecito, San Diego County, and Carrizo Creek, north slope Santa Rosa Mountains, Riverside County (Mus. Vert. Zool.); also Turtle Mountains, near Blythe Junction, San Bernardino County (Camp, Univ. Calif. Publ. Zool., **12**, 1916, p. 512); Furnace Creek, Death Valley, and Cottonwood Cañon [Jackass Spring], Panamint Mountains, in Inyo County (Stejneger, N. Amer. Fauna, **7**, 1893, p. 219). Life-zone, Lower Sonoran. Inhabits rocky cañon bottoms, near springs or streams. (See fig. 4.)

Bufo alvarius Girard

Colorado River Toad

Original Description.—*Bufo alvarius* Girard, *in* Baird, U. S. Mex. Bound. Surv., **2**, 1859, pt. 2, reptiles, p. 26, pl. 41, figs. 1–6.

Type Locality.—Valley of Gila and Colorado: Fort Yuma, California (see Cope, U. S. Nat. Mus. Bull., **34**, 1889, p. 267).

Common Names.—Girard's Toad; Colorado Toad.

Range.—Immediate valley of the Colorado River. Has been taken in the delta region west to Meloland (Mus. Vert. Zool.); all known localities for the state are in Imperial County. Life-zone, Lower Sonoran. Inhabits only riparian bottom-lands and irrigated districts. (See fig. 4.)

Family HYLIDAE

Subfamily Hylinae

Hyla regilla Baird and Girard

Pacific Tree-frog

Original Description.—*Hyla regilla* Baird and Girard, Proc. Acad. Nat. Sci. Phila., **6**, 1852, p. 174.

Type Locality.—Sacramento River, California.

Synonyms.—*Litoria occidentalis* Baird and Girard, Proc. Acad. Nat. Sci. Phila., **6**, 1853, p. 301 (type from San Francisco); *Hyla scapularis; Hyla nebulosa* Hallowell, Proc. Acad. Nat. Sci. Phila., **7**, 1854, pp. 96–97 (type from Tejon Pass, probably near Fort Tejon, Kern County); *Hyla scapularis* var. *hypochondriaca* Hallowell, Proc. Acad. Nat. Sci. Phila., **7**, 1854, p. 97 (type from Tejon Pass); *Hyla cadaverina* (a name to replace *nebulosa* of Hallowell: Cope, Journ. Acad. Nat. Sci. Phila., ser. 2, **6**, 1866, p. 84); *Hyla regilla* var. *scapularis.*

Common Names.—Western Tree-frog; Wood-frog; Pacific Hyla; Tree-toad, part; Cadaverous Hyla; Greeny; Cape San Lucas Hyla.

Range.—Almost throughout the state, except in the extreme southeastern desert district. Occurs on Santa Rosa, Santa Cruz, and Santa Catalina islands (Van Denburgh, Proc. Calif. Acad. Sci., ser. 4, **4**, 1914, pp. 132, 135, 137). Extends to timber-line in the Sierra Nevada; occurs in all zones below Alpine-Arctic. Inhabits damp recesses among rocks and logs; the ground in the vicinity of springs, streams, and lakes; rank growths of vegetation, especially in marshy places; trees in damp forests; and, in open country, burrows of various animals.

Hyla arenicolor Cope

Arizona Tree-frog

Original Description.—*Hyla arenicolor* Cope, Journ. Acad. Nat. Sci. Phila., ser. 2, **6**, 1866, p. 84 (a name to replace *Hyla affinis*, Baird, Proc. Acad. Nat. Sci. Phila., **7**, 1854, p. 61).

Type Locality.—Northern Sonora [Mexico or Arizona?].

Synonyms.—*Hyla copii; Hyla versicolor.*

Common Names.—Cope's Tree-frog; Tree-toad, part; Cope's Hyla; Sand-colored Tree Frog.

Range.—Northwest from Julian, La Puerta, and Mountain Spring, in eastern San Diego County, to near Nordhoff, Ventura County, and Santa Monica Mountains, Los Angeles County; east to Little Rock Creek, Los Angeles County, and to Banning, Dos Palmos Spring, and Deep Cañon, Riverside County; also on Pine Mountain, near Escondido, San Diego County (Mus. Vert. Zool.; Richardson, Amer. Nat., **46**, 1912, pp. 605–611). Occupies chiefly the Upper Sonoran life-zone, extending locally into Lower Sonoran. Lives on boulders and exposed rock faces close to cañon streams.

Family RANIDAE
Subfamily Raninae

Rana boylii boylii Baird

California Yellow-legged Frog

Original Description.—*Rana boylii* Baird, Proc. Acad. Nat. Sci. Phila., **7**, 1854, p. 62.

Type Locality.—California; subsequently designated as El Dorado [Eldorado County?] (see Cope, U. S. Nat. Mus. Bull., **34**, 1889, p. 447).

Synonyms.—*Rana pachyderma* Cope, Proc. Acad. Nat. Sci. Phila., 1883, pp. 25–27 (types from McCloud River [= Baird, Shasta County], California, and Ashland, Oregon); [?] *Rana temporaria pretiosa*, part.

Common Names.—Thick-skinned Frog; Boyle's Frog.

Range.—Northern and central portions of the state, chiefly west of the high Sierra Nevada, both along the coast and in the interior valleys. Has been found east to Baird, Shasta County (Cope, *loc. cit.*), to Fyffe, Eldorado County (Mus. Vert. Zool.), and to near Feliciana Mountain, 3800 feet altitude, Mariposa County (Mus. Vert. Zool.). Southernmost station, Bodfish, on Kern River, Kern County (Mus. Vert. Zool.). Has also been taken at Mono Lake, Mono County (Mus. Vert. Zool.). Life-zones, Upper Sonoran and Transition. Inhabits margins of springs, streams, and fresh-water lakes. (See fig. 5.)

Rana boylii sierrae Camp

Sierra Nevada Yellow-legged Frog

Original Description.—*Rana boylii sierrae* Camp, Univ. Calif. Publ. Zool., **17**, February 3, 1917, pp. 120–123, fig. 2.

Type Locality.—Matlack Lake, 10,500 feet altitude, near Kearsarge Pass, Sierra Nevada, Inyo County, California.

Synonyms.—*Rana aurora*, part; *Rana pretiosa*, part; [?] *Rana temporaria pretiosa*, part.

Common Names.—Western Frog; Pacific Frog.

Range.—High Sierra Nevada, 7000 to 10,500 feet altitude. Northernmost station, Young Lake, Yosemite National Park, Tuolumne County; southernmost, Taylor Meadow, near Kern County line, Tulare County (Mus. Vert. Zool.). Occupies the Canadian and Hudsonian life-zones. Lives chiefly in lakes and along streams in meadows. (See fig. 5.)

Rana boylii muscosa Camp

Sierra Madre Yellow-legged Frog

Original Description.—*Rana boylii muscosa* Camp, Univ. Calif. Publ. Zool., **17**, February 3, 1917, pp. 118–120.

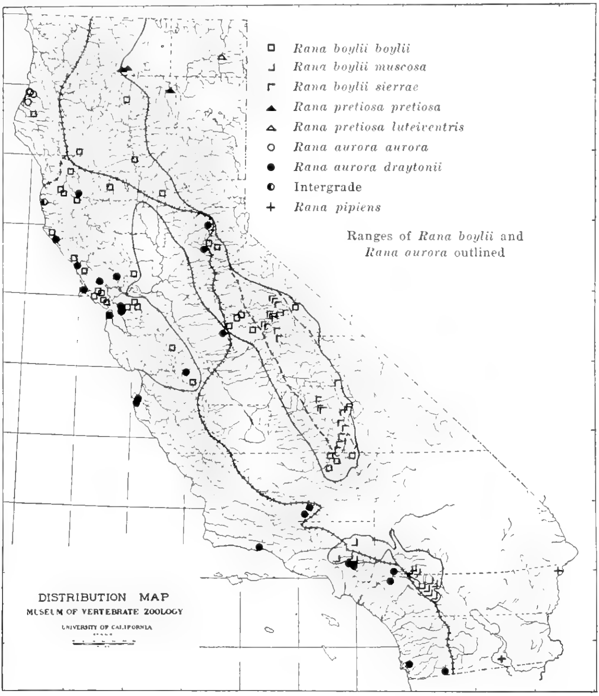

Fig. 5. Distribution of Frogs (*Rana*) in California.

Type Locality.—Arroyo Seco Cañon, near Pasadena, California.

Range.—San Gabriel (both the desert and Pacific drainages), San Bernardino and San Jacinto mountains. Northwesternmost stations for typical specimens, Arroyo Seco Cañon near Pasadena, and Little Rock Creek, in Los Angeles County; southeasternmost station, Strawberry Valley, Riverside County (Mus. Vert. Zool.). Occupies the Upper Sonoran and Transition life-zones. Lives along streams in narrow rock-walled cañons. (See fig. 5.)

Rana pretiosa pretiosa Baird and Girard

Western Spotted Frog

Original Description.—*Rana pretiosa* Baird and Girard, Proc. Acad. Nat. Sci. Phila., **6**, 1853, p. 378.

Type Locality.—Puget Sound.

Range.—Extreme northern end of the state. Definite stations of occurrence are Fall City Mills, Fall River, Shasta County (U. S. Nat. Mus., no. 38806), and vicinity of Sisson, Siskiyou County (Mus. Vert. Zool. and U. S. Nat. Mus.). Life-zone, Transition. Inhabits marshes and lakes. (See fig. 5.)

Rana pretiosa luteiventris Thompson

Nevada Spotted Frog

Original Description.—*Rana pretiosa luteiventris* Thompson, Proc. Biol. Soc. Wash., **26**, March 22, 1913, pp. 53–55, pl. 3, figs. 2, 3.

Type Locality.—Anne Creek, Elko County, Nevada.

Range.—Eastern Modoc County. Only station, Pine Creek, near Alturas, Modoc County (Mus. Vert. Zool., nos. 2098, 2099). Specimens captured on banks of a slow-flowing stream. (See fig. 5.)

Rana aurora aurora Baird and Girard

Oregon Red-legged Frog

Original Description—*Rana aurora* Baird and Girard, Proc. Acad. Nat. Sci. Phila., **6**, 1852, p. 174.

Type Locality.—Puget Sound.

Range.—Extreme northwestern corner of the state. Stations of capture all in vicinity of Eureka, Humboldt County (Mus. Vert. Zool.). (See fig. 5.)

Rana aurora draytonii Baird and Girard

California Red-legged Frog

Original Description.—*Rana Draytonii* Baird and Girard, Proc. Acad. Nat. Sci. Phila., **6**, 1852, p. 174.

Type Locality.—San Francisco, California.

Synonyms.—*Rana Lecontii* Baird and Girard, Proc. Acad. Nat. Sci. Phila., **6**, 1853, pp. 301–302 (type from San Francisco); *Rana* *nigricans* Hallowell, Proc. Acad. Nat. Sci. Phila., **7**, 1854, p. 96 (type from El Paso Creek, Kern County, California); *Rana longipes* Hallowell, Pac. R. R. Rep., **10**, 1859, Williamsons' Rep., pt. 4, no. 1, pp. 20–21 (type from El Paso Creek, Kern County, California); *Epirhexis longipes; Rana agilis aurora; Rana catesbiana; Rana septentrionalis; Rana temporaria; Rana temporaria aurora.*

Common Names.—Drayton's Frog; Bull-frog; Long-footed Frog; Bloody Nouns; Rocky Mountain Frog; Western Wood Frog; Leconte's Frog.

Range.—Central and southern portions of the state, west of the Sierran divides. Extends from the seaboard east to about 3500 feet altitude on the west slope of the central Sierra Nevada. Northern stations are: Mendocino City, Mendocino County, and Michigan Bluff, Placer County (Mus. Vert. Zool.); easternmost station at the south: Campo, San Diego County (Mus. Vert. Zool.). Intergradation with *R. a. aurora* takes place in western Mendocino and Humboldt counties. Inhabits chiefly the Upper Sonoran life-zone, but extends into Transition and Lower Sonoran. Lives in damp places and about springs, streams, and ponds. (See fig. 5.)

Rana pipiens Schreber

Leopard Frog

Original Description.—*Rana pipiens* Schreber, Naturforscher, **18**, 1782, pp. 185–191.

Type Locality.—New York [State].

Synonym.—*Rana pipiens brachycephala.*

Range.—Along the Colorado River, north at least to near Riverside Mountain, Riverside County, and in the Imperial Valley, six miles west of Imperial (Mus. Vert. Zool.). Life-zone, Lower Sonoran. Inhabits river banks and fresh-water sloughs. (See fig. 5.)

Class REPTILIA

Order SQUAMATA

Suborder SAURIA

Family EUBLEPHARIDAE

Coleonyx variegatus (Baird)

Banded Gecko

Original Description.—*Stenodactylus variegatus* Baird, Proc. Acad. Nat. Sci. Phila., 1858 [1859], p. 254.

Type Locality.—Rio Grande and Gila valleys: really Colorado Desert, in southern California (see Stejneger, N. Amer. Fauna, **7**, 1893, p. 163).

Synonym.—*Eublepharis variegatus.*

Common Names.—Variegated Gecko; Variegated Lizard.

Range.—Southeastern desert areas. Occurs north to Big Pine, Owens Valley, Inyo County (Mus. Vert. Zool.); west to Mohave, Kern County (Stejneger, *loc. cit.*, p. 164), to Colton, San Bernardino County (Mus. Vert. Zool.), to San Jacinto, Riverside County (Van Denburgh, Occ. Papers Calif. Acad. Sci., **5**, 1897, p. 41), and to La Puerta Valley, San Diego County (Stephens, MS.). Restricted to the Lower Sonoran life-zone. Lives under stones and other objects and in burrows in the ground. (See fig. 9.)

Family IGUANIDAE

Subfamily Iguaninae

Dipso-saurus dorsalis (Baird and Girard)

Desert Iguana

Original Description.—*Crotaphytus dorsalis* Baird and Girard, Proc. Acad. Nat. Sci. Phila., **6**, 1852, p. 126.

Type Locality.—Desert of Colorado, California.

Common Names.—Crested Lizard; Colorado Desert Lizard; Keel-backed Lizard; Thirsty Lizard; Sharp-back Lizard.

Range.—Extreme desert areas east of the Sierran divides. Occurs north to Owens, Panamint, Death (Mesquite), and Amargosa valleys (Stejneger, N. Amer. Fauna, **7**, 1893, p. 165); west to Coyote Wells, Imperial County (Cope, Rep. U. S. Nat. Mus., 1898 [1900], p. 245); Torres [Toro], Riverside County (Mus. Vert. Zool.); Daggett, San Bernardino County (Meek, Field Columb. Mus., zool. ser., **7**, 1905 [1906], p. 7), and 3 miles east of Owens Lake, Inyo County (Stejneger, *loc. cit.*). Restricted to the Lower Sonoran life-zone. Lives on level, sandy, or gravelly ground.

Uma notata Baird

Ocellated Sand Lizard

Original Description.—*Uma notata* Baird, Proc. Acad. Nat. Sci. Phila., 1858 [1859], p. 253.

Type Locality.—Mohave Desert [=Colorado Desert, in California?].

Synonyms.—*Uma inornata* Cope, Amer. Nat., **29**, 1895, p. 939 (type from Colorado Desert, "San Diego" [=Imperial] County); *Uma rufopunctata*.

Common Names.—Ocellated Desert Lizard; Red-spotted Desert Lizard; Cope's Desert Lizard; Spotted Yuma Lizard.

Range.—Mohave and Colorado deserts; occurs west to near Signal Mountain, Imperial County (Mus. Vert. Zool.), and north at least to Daggett, San Bernardino County (Meek, Field Columb. Mus., zool. ser., **7**, 1906, pp. 4–7), and near Blythe Junction, in Riverside County (Camp, Univ. Calif. Publ. Zool., **12**, 1916, pp. 516–519). Occurs only within the Lower Sonoran life-zone, where further restricted to tracts of eolian sand.

Callisaurus ventralis ventralis (Hallowell)

Southern Gridiron-tailed Lizard

Original Description.—*Homolosaurus* [corrected in "Errata" to *Homalosaurus*] *ventralis* Hallowell, Proc. Acad. Nat. Sci. Phila., **6**, 1852, pp. 179–180.

Type Locality.—New Mexico [west of the Rio Grande].

Synonyms.—*Callisaurus draconoides; Callisaurus draconoides ventralis; Callisaurus dracontoides gabbii.*

Common Names.—Zebra-tailed Lizard; Spotted-tail Dragon; Beautiful Lizard.

Range.—Entire desert area of southeastern California. Occurs north into Inyo County: Independence in Owens Valley (Swarth, MS), Saline Valley, Furnace Creek in Death Valley, and the Funeral Range (Stejneger, N. Amer. Fauna, **7**, 1893, p. 173); west to Kelso Creek, near Weldon, Kern County (Mus. Vert. Zool.), to Cameron, 8 miles northwest of Mohave, Kern County (Stejneger, *loc. cit.*), to western Antelope Valley, Los Angeles County (Camp, MS), to Cajon Wash, San Bernardino County (Mus. Vert. Zool.), and to near Banning, Riverside County (Van Denburgh, Occ. Papers Calif. Acad. Sci., **5**, 1897, p. 50). Occurs also at Vallevista, in San Jacinto Valley, Riverside County (Atsatt, Univ. Calif. Publ. Zool., **12**, 1913, p. 33), and Oak Springs, San Diego County (Van Denburgh, *loc. cit.*). Occupies the Lower Sonoran life-zone. Inhabits level gravelly or sandy plains and washes.

Crotaphytus wislizenii Baird and Girard

Great Basin Leopard Lizard

Original Description.—*Crotaphytus Wislizenii* Baird and Girard, Proc. Acad. Nat. Sci. Phila., **6**, 1852, p. 69.

Type Locality.—Near Santa Fé, New Mexico.

Synonyms.—*Crotaphytus Gambelii* Baird and Girard, *loc. cit.*, p. 126 (type possibly from California: see Stejneger, N. Amer. Fauna, **3**, 1890, p. 105, footnote); *Crotaphytus fasciatus*, part; [?] *Crotaphytus silus*, part.

Common Name.—Wislizenius' Lizard, part.

Range.—Arid interior chiefly east of the desert divides. Occurs north through the Inyo region to Benton, Mono County (Mus. Vert. Zool.); also recorded from Doyle, Lassen County (Richardson, Proc. U. S. Nat. Mus., **48**, 1915, p. 407). Occurs west across Owens Valley to Carroll Creek, west of Owens Lake, Inyo County (Mus. Vert. Zool.); through Kern gap in vicinity of Walker Pass to Bodfish, Kern County (Mus. Vert. Zool.); through Tejon Pass and Cuddy Cañon to Lockwood Valley, 5000 feet altitude, Ventura County (Meek, Field Columb. Mus., zool. ser., **7**, 1905 [1906], p. 8); to 2 miles west of Pallett, Los Angeles County (Mus. Vert. Zool.); to Cushenbury Springs, San Bernardino County (Grinnell, Univ. Calif. Publ. Zool., **5**, 1908, p. 160); through San Gorgonio Pass to Cabezon, Riverside County (Atsatt, Univ. Calif. Publ. Zool., **12**, 1913, p. 34); also to San Jacinto, Riverside County (Van Denburgh, Occ. Papers Calif. Acad. Sci., **5**, 1897, p. 58); to Pinyon Flat, 4000 feet altitude, on east slope Santa Rosa Mountains, Riverside County (Atsatt, *loc. cit.*); and to Oak Grove, San Diego County (McLain, Crit. Notes Coll. Reptiles Western U. S., 1899, p. 2). Occupies the Lower and Upper Sonoran life-zones. Inhabits level or rolling ground of sandy or gravelly nature.

Crotaphytus silus Stejneger

San Joaquin Leopard Lizard

Original Description.—*Crotaphytus silus* Stejneger, N. Amer. Fauna, **3**, 1890, p. 105.

Type Locality.—Fresno, Fresno County, California.

Synonyms.—*Crotaphytus wislizenii*, part; *Crotaphytus fasciatus*, part.

Common Names.—Short-nosed Leopard Lizard; Wislizenius' Lizard, part; Banded Lizard.

Range.—Southern San Joaquin Valley (Tulare basin), and Carrizo Plain, San Luis Obispo County. Occurs north to Livingston, Merced County (McLain, Crit. Notes Coll. Reptiles Western U. S., 1899, p. 2); east to Poso, Bakersfield, and Pampa, in Kern County (Stejneger, N. Amer. Fauna, **7**, 1893, p. 170); south to 5 miles north of Rose Station (Stejneger, *loc. cit.*), and to San Emigdio Plains (Mus. Vert. Zool.), Kern County; then, on Carrizo Plain, west to Painted Rock, San Luis Obispo County. Restricted to the Lower Sonoran life-zone. Inhabits level valley floors.

Crotaphytus collaris baileyi Stejneger

Bailey Collared Lizard

Original Description.—*Crotaphytus baileyi* Stejneger, N. Amer. Fauna, **3**, 1890, pp. 103–105, pl. 12, fig. 1.

Type Locality.—Painted Desert, Little Colorado River, Arizona.

Synonym.—*Crotaphytus collaris.*

Common Name.—Bailey Leopard Lizard.

Range.—Of interrupted distribution on the southeastern deserts, occurring north through the Inyo region to Deep Spring Valley slope of White Mountains, 5600 feet altitude, Inyo County (Stejneger, N. Amer. Fauna, **7**, 1893, p. 166). Has been taken west to 5 miles north of Kernville, Kern County (Mus. Vert. Zool.); to Lytle Creek, San Bernardino County (Van Denburgh, Proc. Calif. Acad. Sci., ser. 4, **3**, 1912, p. 147); to Hall Grade, near Cabezon, Riverside County (Atsatt, Univ. Calif. Publ. Zool., **12**, 1913, p. 33); to Palm Cañon, San Jacinto Mountains, Riverside County (Atsatt, *loc. cit.*); and to Mountain Spring, eastern San Diego County (Cope, Ann. Rep. U. S. Nat. Mus., 1898 [1900], p. 252). Not known from region of Colorado River south of near Blythe Junction, in Riverside County (Camp, Univ. Calif. Publ. Zool., **12**, 1916, p. 521). Occurs in the Lower and Upper Sonoran life-zones. Restricted to rocky situations.

Sauromalus ater Duméril

Chuckwalla

Original Description.—*Sauromalus ater* Duméril, Arch. Mus. Hist. Nat., **8**, 1856, pp. 536–538, pl. 23, figs. 3, 3*a*.

Type Locality.—Unknown.

Synonym.—*Euphryne obesus* Baird, Proc. Acad. Nat. Sci. Phila., 1858 [1859], p. 253 (type no. 4172, U. S. Nat. Mus., from Fort Yuma, California).

Common Names.—Alderman Lizard; Fat Toad Lizard; Fat Lizard.

Range.—Desert mountains of southeastern California. Occurs north to Willow Creek, 4500 feet altitude, Panamint Mountains, Inyo County (Stejneger, N. Amer. Fauna, **7**, 1893, p. 175); west to Shepherd Cañon, Argus Range, Inyo County (Stejneger, *loc. cit.*); to Barstow and Victorville, San Bernardino County (Mus. Vert. Zool.); to Snow Creek, San Jacinto Mountains, and Dos Palmos Spring, Santa Rosa Mountains, in Riverside County (Atsatt, Univ. Calif. Publ. Zool., **12**, 1913, p. 34); and to Coyote Well, Imperial County (Cope, Ann. Rep. U. S. Nat. Mus., 1898 [1900], p. 268), and east slope of "Julian Mountains" [= Cuyamaca Mountains?], in eastern San Diego County (Van Denburgh, Occ. Papers Calif. Acad. Sci., **5**, 1897, p. 62). Restricted to the Lower Sonoran life-zone, where it occurs only in rocky situations.

Uta mearnsi Stejneger

Mearns Lizard

Original Description.—*Uta mearnsi* Stejneger, Proc. U. S. Nat. Mus., **17**, November, 1894, pp. 589–591.

Type Locality.—Summit of Coast Range, United States and Mexican boundary line, California.

Common Name.—Mearns Swift.

Range.—Desert slopes of San Jacinto, Santa Rosa and Coast ranges, in Riverside and San Diego counties. Has been taken northeast to Banning, Cabezon, Snow Creek and Palm Cañon, in Riverside County (Atsatt, Univ. Calif. Publ. Zool., **12**, 1913, pp. 34–35), west to La Puerta, San Diego County (Mus. Vert. Zool.), and south to the type locality, as above given. Altitudes of occurrence extend from 800 to 3500 feet. Occurs in the Lower Sonoran life-zone, extending locally into Upper Sonoran. Lives on boulders and faces of cliffs.

Uta stansburiana stansburiana Baird and Girard

Northern Brown-shouldered Lizard

Original Description.—*Uta Stansburiana* Baird and Girard, Proc. Acad. Nat. Sci. Phila., **6**, 1852, p. 69.

Type Locality.—Valley of Great Salt Lake, Utah.

Range.—Enters California from Nevada in the Inyo region.

Specimens recorded from Round Valley and near Lone Pine, in Inyo County (Richardson, Proc. U. S. Nat. Mus., **48**, 1915, p. 412). Additional specimens in Mus. Vert. Zool., from vicinity of Independence and Laws, Inyo County, and from Benton, Mono County. Occupies

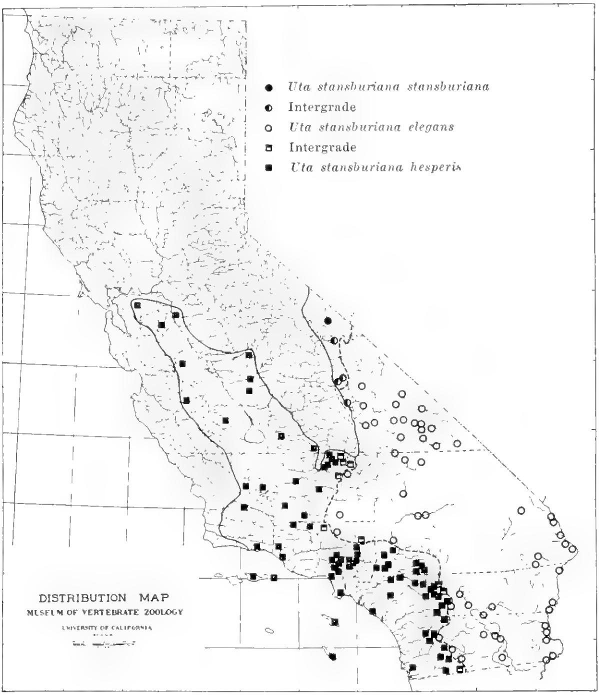

Fig. 6. Distribution of *Uta stansburiana* in California.

the Upper Sonoran life-zone. Inhabits chiefly sandy or gravelly ground among bushes. (See fig. 6.)

Uta stansburiana elegans Yarrow

Desert Brown-shouldered Lizard

Original Description.—*Uta elegans* Yarrow, Proc. U. S. Nat. Mus., **5**, 1882, p. 442.

Type Locality.—La Paz, Lower California, Mexico.

Synonym.—*Uta stansburiana*, part.

Common Names.—Stansbury's Swift, part; Stansbury's Uta, part; Brown-shouldered Lizard, part.

Range.—The southeastern deserts. Has been captured north to Carroll Creek and Keeler, Inyo County; west to the Pacific divides, where intergradation takes place with *U. s. hesperis*. Intergradation with *U. s. stansburiana* takes place in Owens Valley, Inyo County (Mus. Vert. Zool.). Occupies chiefly the Lower Sonoran life-zone. Inhabits nearly all types of desert environment except sand dunes. (See fig. 6.)

Uta stansburiana hesperis Richardson

Southern Brown-shouldered Lizard

Original Description.—*Uta stansburiana hesperis* Richardson, Proc. U. S. Nat. Mus., **48**, January 19, 1915, pp. 415–418.

Type Locality.—Arroyo Seco Cañon, near Pasadena, Los Angeles County, California.

Synonym.—*Uta stansburiana*, part.

Common Names.—Brown-shouldered Lizard, part; Stansbury's Swift, part; Stansbury's Uta, part.

Range.—Coastal slopes of southern California and the San Joaquin Valley. Northernmost stations, Mount Diablo, Contra Costa County (Univ. Calif. Dept. Zool.), and 5 miles south of Lathrop, San Joaquin County (Van Denburgh, Occ. Papers Calif. Acad. Sci., **5**, 1897, p. 68; Camp, Univ. Calif. Publ. Zool., **17**, 1916, p. 69). Extends northeast to Fresno and west in central California to Bear Valley, San Benito County (Van Denburgh, *loc. cit.*). Occurs also on Santa Cruz, Ana Capa, Santa Catalina, and San Clemente islands. Intergrades on the east, through Walker Pass and across the desert divides in southern California, with *U. s. elegans* (Mus. Vert. Zool.). Occupies the Lower Sonoran life-zone and to a lesser extent the Upper Sonoran life-zone. Inhabits arid plains, washes, the more open, dry hill-slopes, and, along the seacoast, sand dunes. (See fig. 6.)

Uta graciosa (Hallowell)

Long-tailed Uta

Original Description.—*Uro-saurus graciosus* Hallowell, Proc. Acad. Nat. Sci. Phila., **7**, 1854, pp. 92–93.

Type Locality.—Lower [=southern?] California.

Synonym.—*Anolis cooperi* Baird, Proc. Acad. Nat. Sci. Phila., 1858 [1859], p. 254 (type from California).

Common Names.—Long-tailed Swift; Graceful Uta; Cooper's Green Lizard; Slender Lizard.

Range.—Colorado Desert, in vicinity of Colorado River, and west at least to Blythe Junction and Goffs (Blake P. O.), Riverside and San Bernardino counties (Camp, Univ. Calif. Publ. Zool., **12**, 1916, pp. 525–526), and Meloland, Imperial County (Mus. Vert. Zool.). Restricted to the Lower Sonoran life-zone. Lives in bushes and desert trees.

Uta ornata Baird and Girard

Tree Uta

Original Description.—*Uta ornata* Baird and Girard, Proc. Acad. Nat. Sci. Phila., **6**, 1852, p. 126.

Type Locality.—Rio San Pedro (Texas) and province of Sonora [=Arizona].

Synonyms.—*Uta symmetrica* Baird, Proc. Acad. Nat. Sci. Phila., 1858 [1859], p. 253 (type from Fort Yuma); [?] *Anolis carolinensis;* [?] *Anolis principalis;* [?] *Uta schottii* Baird, *loc. cit.* (type from "Sta. Madelina, Cal.").

Common Names.—Ornate Swift; White-bellied Swift; Ornate Uta; Tree Swift; Graceful Lizard; [?] Schott's Lizard.

Range.—Valley of the Colorado River north at least to vicinity of Palo Verde, Imperial County (Mus. Vert. Zool.). Restricted to the Lower Sonoran life-zone. Lives on trunks of trees in the river bottom.

Sceloporus graciosus graciosus Baird and Girard

Mountain Lizard

Original Description.—*Sceloporus graciosus* Baird and Girard, Proc. Acad. Nat. Sci. Phila., **6**, 1852, p. 69.

Type Locality.—Valley of the Great Salt Lake [Utah].

Synonyms.—[?] *Sceloporus consobrinus; Scelopurus consobrinus gratiosus.*

Common Names.—New Mexican Alligator Lizard; Sage-brush Swift, part; Fence Lizard, part; Marcy's Alligator Lizard.

Range.—Chiefly mountainous districts from 2400 feet altitude in the southern Sierras (Bodfish, Kern County) and 700 feet in the inner northern coast ranges (3 miles west of Vacaville, Solano County) to 8100 feet in Mariposa County (near Porcupine Flat) (Mus. Vert. Zool.). Occurs typically south to Mount Pinos, Ventura County. Ranges west to South Yolla Bolly Mountain, 6 miles south of Covelo,

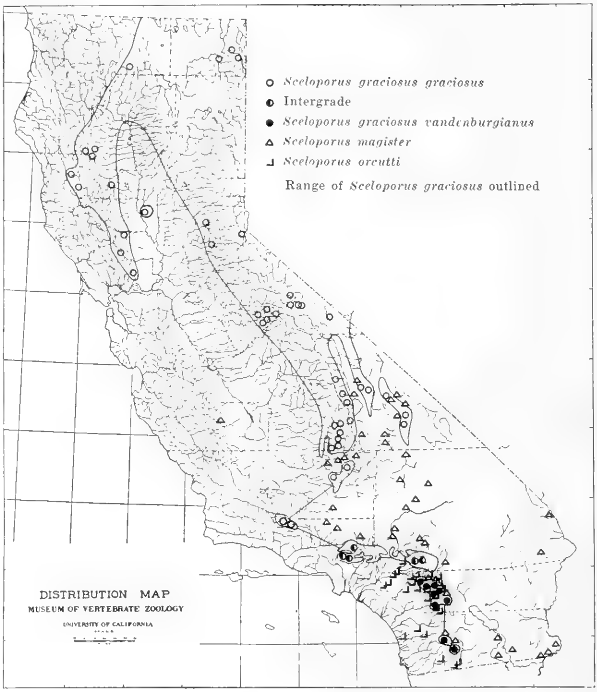

Fig. 7. Distribution of *Sceloporus graciosus, S. magister,* and *S. orcutti* in California.

and Mount Sanhedrin, in Trinity and Mendocino counties (Mus. Vert. Zool.); and south in the Sierra Nevada as far as Mount Breckinridge, 6500 feet altitude, in Kern County (Mus. Vert. Zool.). Occurs also on the Warner Mountains, from 4700 to 5000 feet altitude, Modoc County (Mus. Vert. Zool.); about Mono Lake and at Benton, in Mono County (Mus. Vert. Zool), and on the Panamint Mountains, 6400 feet altitude, Inyo County (Stejneger, N. Amer. Fauna, **7**, 1893, p. 184). Occupies chiefly the Transition life-zone, but extends locally into the Canadian on the one hand and more commonly into the Upper Sonoran on the other. Lives on and about rocks and logs and on the ground among bushes. (See fig. 7.)

Sceloporus graciosus vandenburgianus Cope

Van Denburgh Lizard

Original Description.—*Sceloporus vandenburgianus* Cope, Amer. Nat., **30**, 1896, pp. 834–836.

Type Locality.—Summit of Coast Range [probably Laguna Mountains], San Diego County, California.

Synonym.—*Sceloporus graciosus*, part.

Common Names.—Mountain Lizard, part; Van Denburgh's Swift; Sage-brush Swift, part.

Range.—Cuyamaca, Santa Rosa, San Jacinto, San Bernardino, and San Gabriel mountains, from 4000 to 8500 feet altitude. Northwesternmost station: Pine Flats, in San Gabriel Mountains, Los Angeles County (Mus. Vert. Zool.). Intergradation with *S. g. graciosus* is shown by specimens from San Bernardino and San Gabriel mountains (see Camp, Univ. Calif. Publ. Zool., **17**, 1916, pp. 67–68). Occupies the Transition life-zone. Lives on and about rocks and logs and on the ground among bushes. (See fig. 7.)

Sceloporus occidentalis occidentalis Baird and Girard

Pacific Blue-bellied Lizard

Original Description.—*Sceloporus occidentalis* Baird and Girard, Proc. Acad. Nat. Sci. Phila., **6**, 1852, p. 175.

Type Locality.—California [by inference from next subsequent published definite statement, Benicia (Baird, Pac. R. R. Rep., **10**, 1859, Abbot's Rep., pt. 4, no. 4, p. 9)].

Synonyms.—*Sceloporus undulatus* var. *bocourtii* Boulenger, Cat. Lizards Brit. Mus., ed. 2, **2**, 1885, p. 229, part (specimens listed from Monterey, Mt. Whitney, and Santa Cruz [!]); *Sceloporus frontalis; Sceloporus undulatus occidentalis,* part; *Sceloporus undulatus undulatus,* part; *Sceloporus undulatus thayeri,* part.

Common Names.—Western Fence Lizard; Western Alligator Lizard, part; Pacific Swift; Thayer's Alligator Lizard, part; Alligator Lizard, part.

Range.—Northern and west-central portions of the state, including both the coast district and Sacramento and San Joaquin valleys. Occurs east to the Warner Mountains, Modoc County, and into the foothills of the Sierra Nevada as far as Fyffe, Eldorado County, and Yosemite Valley, Mariposa County (Mus. Vert. Zool.); south to Snelling and 22 miles south of Los Baños, in Merced County, and to San Luis Obispo (Mus. Vert. Zool.). In the vicinity of the latter points intergradation with *S. o. bi-seriatus* takes place, as also in eastern Modoc County (see Camp, Univ. Calif. Publ. Zool., **17**, 1916, pp. 63-65). Occupies the Upper Sonoran and Transition life-zones. Lives on tree-trunks, fences, logs, boulders, and in steep banks. (See fig. 8.)

Sceloporus occidentalis taylori Camp

Tenaya Blue-bellied Lizard

Original Description.—*Sceloporus occidentalis taylori* Camp, Univ. Calif. Publ. Zool., **17**, December 28, 1916, pp. 65–67.

Type Locality.—Half-way between Merced Lake and Sunrise Trail, altitude 7500 feet, Yosemite National Park, Mariposa County, California.

Range.—Upper basins of Tuolumne and Merced rivers, between altitudes of 7300 and 8200 feet, in Yosemite National Park. Occupies the Canadian life-zone. Lives on and beneath boulders and in rock-slides. (See fig. 8.)

Sceloporus occidentalis bi-seriatus Hallowell

Fence Lizard

Original Description.—*Sceloporus bi-seriatus* Hallowell, Proc. Acad. Nat. Sci. Phila., **7**, 1854, pp. 93–94.

Type Locality.—Borders of El Paso Creek and in Tejon Valley [both in Kern County, California].

Synonyms.—*Sceloporus longipes* Baird, Proc. Acad. Nat. Sci. Phila., 1858 [1859], p. 254 (type from Fort Tejon, California); *Sceloporus undulatus bocourtii*, part [see under *S. o. occidentalis*]; *Sceloporus undulatus thayeri*, part; *Sceloporus undulatus undulatus*, part; *Sceloporus* [*bi-seriatus*] var. *marmoratus; Sceloporus occidentalis*, part; *Sceloporus bi-seriatus* var. *A. azureus* Hallowell, *loc. cit.*, p. 94 (type locality same as for *S. bi-seriatus*); *Sceloporus bi-seriatus* var. *B. variegatus* Hallowell, *loc. cit.*, p. 94 (type locality same as for *S. bi-seriatus*).

Common Names.—Fence Swift; Western Swift; Two-lined Lizard; Thayer's Alligator Lizard, part; Western Alligator Lizard, part; Blue-bellied Lizard, part; Common Swift; Long-footed Lizard; Two-striped Lizard.

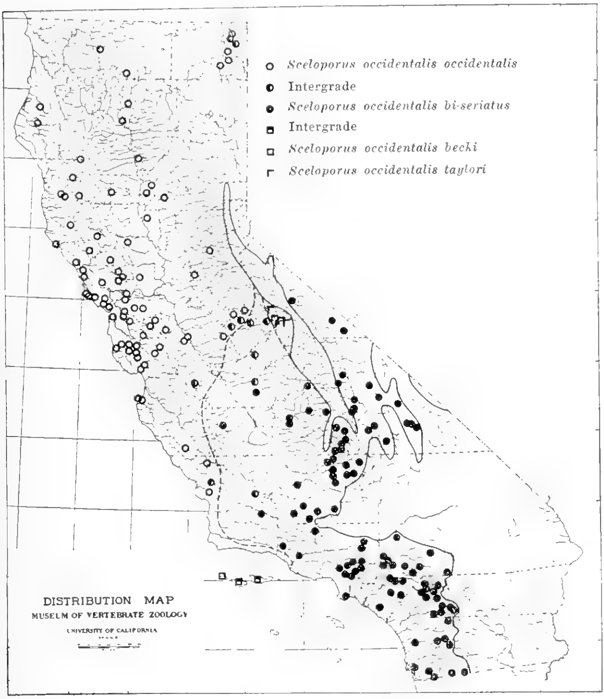

Fig. 8. Distribution of Blue-bellied Lizards (*Sceloporus occidentalis*) in California.

Range.—East-central and southwestern portions of the state. Occurs north to Matilija, Ventura County, to Carrizo Plain, San Luis Obispo County, to Raymond, Madera County, and to Mono Lake, Mono County (Mus. Vert. Zool.); east to Benton, Mono County, to Carroll Creek, Inyo County, to west slope of Walker Pass, Kern

County, to Pallett, Los Angeles County, to Victorville and Cushenberry Springs, San Bernardino County, to Cabezon, Strawberry Valley, and Santa Rosa Mountains at 6000 feet altitude, in Riverside County, and to Warner Pass and Jacumba (2825 feet altitude), in eastern San Diego County (all above localities represented by specimens in Mus. Vert. Zool.). Extends altitudinally as high as 10,000 feet near Kearsarge Pass on eastern declivity of Sierra Nevada in Inyo County (Mus. Vert. Zool.). Occurs also, in the Inyo region, on the Coso, Argus, Panamint, Inyo, and White mountains (Stejneger, N. Amer. Fauna, **7,** 1893, pp. 185–186). Occupies the Lower and Upper Sonoran life-zones and extends locally into Transition. Lives on tree-trunks, fences, sides of buildings, and among rocks of large size. (See fig. 8.)

Sceloporus occidentalis becki Van Denburgh

Island Blue-bellied Lizard

Original Description.—*Sceloporus becki* Van Denburgh, Proc. Calif. Acad. Sci., ser. 3, zool., **4**, June 15, 1905, pp. 9–10, pl. 4.

Type Locality.—San Miguel Island, Santa Barbara County, California.

Synonym.—*Sceloporus biseriatus becki.*

Range.—The extreme form of this subspecies occurs only at the type locality; forms intermediate between this and the mainland subspecies are found, according to Van Denburgh (*loc. cit.*) on Santa Rosa and Santa Cruz islands, Santa Barbara County. Lives among large rocks and on tree-trunks. (See fig. 8.)

Sceloporus magister Hallowell

Desert Rough-scaled Lizard

Original Description.—*Sceloporus magister* Hallowell, Proc. Acad. Nat. Sci. Phila., **7,** 1854, p. 93.

Type Locality.—Near Fort Yuma, California.

Synonyms.—*Sceloporus clarkii; Sceloporus spinosus* var. *clarkii;* [?] *Sceloporus orcutti,* part.

Common Names.—Scaly Lizard; Clark's Alligator Lizard; Fence Lizard, part; Clark's Lizard; Great Fence Lizard.

Range.—Entire southeastern desert area, extending north to Lone Pine (Stejneger, N. Amer. Fauna, **7,** 1893, p. 183), to Mazourka Cañon, Inyo Mountains (Mus. Vert. Zool.), and to Willow Creek, Panamint

Mountains (Stejneger, *loc. cit.*), in Inyo County; west through the Kern River gap to Bodfish, Kern County (Mus. Vert. Zool.); also west to Fairmont and Pallett, Los Angeles County (Mus. Vert. Zool.); to Hesperia (Van Denburgh, Occ. Papers Calif. Acad. Sci., **5**, 1897, p. 86) and Cushenbury Springs (Grinnell, Univ. Calif. Publ. Zool., **5**, 1908, p. 162), in San Bernardino County; to Cabezon and Dos Palmos Spring (3000 feet altitude), in Riverside County (Atsatt, Univ. Calif. Publ. Zool., **12**, 1913, p. 37); and to Warner Pass and La Puerta, San Diego County (Mus. Vert. Zool.). There is one record for the west side of the San Joaquin Valley: Los Gatos Cañon, 6 miles north of Coalinga, in Fresno County (Van Denburgh, *loc. cit.*, p. 86). Occupies the Lower Sonoran life-zone. Inhabits tree-yuccas, catclaw thickets, piles of rocks, undercut wash-banks, and railroad culverts. (See fig. 7.)

Sceloporus orcutti Stejneger

Dusky Rough-scaled Lizard

Original Description.—*Sceloporus orcutti* Stejneger, N. Amer. Fauna, **7**, May, 1893, p. 181 (footnote), pl. 1, figs. 4*a*-4*c*.

Type Locality.—Milquatay Valley [about 50 miles east of San Diego], San Diego County, California.

Synonym.—[?] *Sceloporus spinosus.*

Common Names.—Orcutt's Swift; Dusky Scaly Lizard; [?] Spiny Alligator Lizard.

Range.—Mountains of San Diego, western Riverside, and southwestern San Bernardino counties. Occurs northwest to Waterman Cañon, San Bernardino County (Van Denburgh, Proc. Calif. Acad. Sci., ser. 4, **3**, 1912, p. 149); west to Riverside (Van Denburgh, *loc. cit.*) and Temescal (Van Denburgh, Occ. Papers Calif. Acad. Sci., **5**, 1897, p. 88), in Riverside County, and to Escondido, San Diego County (Mus. Vert. Zool.); east to Mountain Spring, San Diego County (Cope, Ann. Rep. U. S. Nat. Mus., 1898 [1900], p. 356); and to Dos Palmos Spring (3500 feet altitude), Snow Creek (2000 feet), and Banning (2200 feet), in Riverside County (Atsatt, Univ. Calif. Publ. Zool., **12**, 1913, p. 37). Extends as high as 5900 feet altitude on west side of San Jacinto Mountains, at Fuller's Mill (Atsatt, *loc. cit.*). Occurs chiefly within the Upper Sonoran life-zone. Lives among boulders surrounded by chaparral. (See fig. 7.)

Phrynosoma douglassii douglassii (Bell)

Pigmy Horned-toad

Original Description.—*Agama Douglassii* Bell, Trans. Linn. Soc. Lond., **16**, 1828, pp. 105–107, pl. 10.

Type Locality.—Columbia River.

Synonyms.—*Phrynosoma douglassi pygmaea; Tapaya Douglassii.*

Common Names.—Pigmy Horned Lizard; Douglass's Horned Toad.

Range.—One definite record from the state: western base of Mount Shasta [= Shasta Valley?], Siskiyou County (Townsend, Proc. U. S. Nat. Mus., **10**, 1887, p. 238).

Phrynosoma blainvillii blainvillii (Gray)

Blainville Horned-toad

Original Description.—*Phrynosoma Blainvillii* Gray, Zool. Beechey's Voyage, 1839, p. 96, pl. 29, fig. 1.

Type Locality.—California: probably San Diego (see Van Denburgh, Proc. Calif. Acad. Sci., ser. 2, **4**, 1894, p. 296).

Synonyms.—*Agama coronatum; Phrynosoma coronatum,* part; *Phrynosoma modestum.*

Common Names.—Pacific Horned Lizard; Blainville's Horned Lizard, part; California Horned Lizard, part; Pacific Horned Toad; Crowned Horned Lizard, part; Little Horned Lizard.

Range.—Mainly west of the desert divides, in San Diego, Orange, Riverside, San Bernardino, and Los Angeles counties. Occurs north to Tujunga Wash, near Sunland, Los Angeles County, and to Cajon Pass, San Bernardino County (Van Denburgh, Proc. Calif. Acad. Sci., ser. 4, **3**, 1912, p. 148); east to Jacumba (Cope, Ann. Rep. U. S. Nat. Mus., 1898 [1900], p. 427), and Warner Pass (Bryant, Univ. Calif. Publ. Zool., **9**, 1911, p. 36), in San Diego County; to Vandeventer Flat, Oak Springs (west side of Palm Cañon, 6500 feet altitude), and Cabezon, in Riverside County (Bryant, *loc. cit.*); and to junction of South Fork (6200 feet altitude) and upper Santa Ana Cañon, San Bernardino Mountains (Grinnell, Univ. Calif. Publ. Zool., **5**, 1908, p. 162). Occupies the Upper and Lower Sonoran life-zones. Inhabits gravelly or sandy ground of a nature to permit burrowing.

Phrynosoma blainvillii frontale Van Denburgh

California Horned-toad

ORIGINAL DESCRIPTION.—*Phrynosoma frontalis* Van Denburgh, Proc. Calif. Acad. Sci., ser. 2, **4**, July 12, 1894, p. 296.

TYPE LOCALITY.—Bear Valley, San Benito County, California.

SYNONYMS.—*Phrynosoma blainvillii,* part; *Phrynosoma coronatum,* part; *Phrynosoma cornutum; Batrachosoma coronatum; Tapaya coronata.*

COMMON NAMES.—California Horned Lizard, part; Spiny-breasted Horned Lizard; Blainville's Horned Lizard, part; Crowned Horned Lizard, part.

RANGE.—West-central California, chiefly west of the desert divides. Occurs north along east side of the Sacramento Valley at least to Colfax, Placer County, and along west side of the San Joaquin Valley to Tracy, San Joaquin County (Bryant, Univ. Calif. Publ. Zool., **9**, 1911, p. 42); west to Berkeley, Alameda County (Mus. Vert. Zool.), and to Searsville, San Mateo County, and Pacific Grove, Monterey County (Van Denburgh, Occ. Papers Calif. Acad. Sci., **5**, 1897, p. 95); east to five miles northeast Coulterville (3100 feet altitude), in Mariposa County (Mus. Vert. Zool.), and Walker Pass (5200 feet altitude), in Kern County (Bryant, *loc. cit.*); southeast to 5 miles south of Neenach, at 4000 feet altitude, and upper Tujunga Cañon, 4500 feet altitude, in northern Los Angeles County (Mus. Vert. Zool.). Intergrades south of latter points, between San Francisquito Cañon and Pasadena, with *P. b. blainvillii.* Inhabits the Upper and Lower Sonoran life-zones. Lives in arid brushy or open situations.

Phrynosoma platyrhinos Girard

Desert Horned-toad

ORIGINAL DESCRIPTION.—*Phrynosoma platyrhinos* Girard, Stansbury's Expl. Gt. Salt Lake, 1853, pp. 361, 363–364, pl. 7, figs. 1–5.

TYPE LOCALITY.—Great Salt Lake, Utah.

SYNONYMS.—*Anota calidiarum* Cope, Amer. Nat., **30**, 1896, pp. 833–834 (type from Death Valley [uncertain]); *Phrynosoma calidiarum; Doliosaurus platyrhinos; Anota platyrhina; Phrynosoma coronatum,* part.

COMMON NAMES.—Desert Horned Lizard; Ashy Horned Toad;

Smooth Horned Lizard; Smooth Horned Toad; Broad-nosed Barrel Lizard; Broad-nosed Horned Toad.

Range.—The southeastern deserts chiefly east of the Pacific divides. Recorded north through the Inyo region to Benton, Mono County (Mus. Vert. Zool.); west to Carroll Creek, Inyo County (Mus. Vert. Zool.), to South Fork Kern River near Chimney Creek (3100 feet altitude) and head of Kelso Valley (5300 feet altitude), in Kern County (Bryant, Univ. Calif. Publ. Zool., **9**, 1911, p. 49); to Fairmont, in northern Los Angeles County (Grinnell and Grinnell, Throop Inst. Bull., **35**, 1907, p. 57); to Victorville, San Bernardino County (Mus. Vert. Zool.); to Whitewater (Atsatt, Univ. Calif. Publ. Zool., **12**, 1913, p. 38), Palm Springs, and Mecca (Bryant, *loc. cit.*), in Riverside County; and to Coyote Wells, in Imperial County (Cope, Ann. Rep. U. S. Nat. Mus., 1898 [1900], p. 447). Occupies the Lower Sonoran life-zone. Lives in open gravelly or sandy situations.

Phrynosoma m'callii (Hallowell)

Flat-tailed Horned-toad

Original Description.—*Anota M'Callii* Hallowell, Proc. Acad. Nat. Sci. Phila., **6**, 1852, p. 182.

Type Locality.—Great Desert of the Colorado, between Vallecito and Camp Yuma, about 160 miles east of San Diego.

Synonym.—*Doliosaurus mc'calli.*

Common Names.—Flat-tailed Horned Lizard; McCall's Horned Lizard; MacCall's Horned Toad.

Range.—The Salton Basin, in Imperial and Riverside counties. Recorded from: Mecca, Riverside County (Bryant, Univ. Calif. Publ. Zool., **9**, 1911, p. 59); Coyote Well (Bryant, *loc. cit.*), Salton Sea (south end) (Bryant, *loc. cit.*), Fort Yuma (Cope, Ann. Rep. U. S. Nat. Mus., 1898 [1900], p. 450), and the type locality (as above), in Imperial County. Restricted to the Lower Sonoran life-zone. Inhabits open tracts of sandy alluvium.

Family ANGUIDAE

Gerrhonotus scincicauda scincicauda (Skilton)

California Alligator Lizard

Original Description.—*Tropidolepis scincicauda* Skilton, Amer. Journ. Arts. Sci., ser. 2, **7**, 1849, p. 202, pl. opp. p. 464, figs. 1–3.

Type Locality.—Dalles of the Columbia [Oregon].

Synonyms.—*Elgaria scincicauda; Gerrhonotus multicarinatus*, part.

Common Names.—Skink-tailed Lizard, part; Many-keeled Lizard, part; Many-ribbed Lizard.

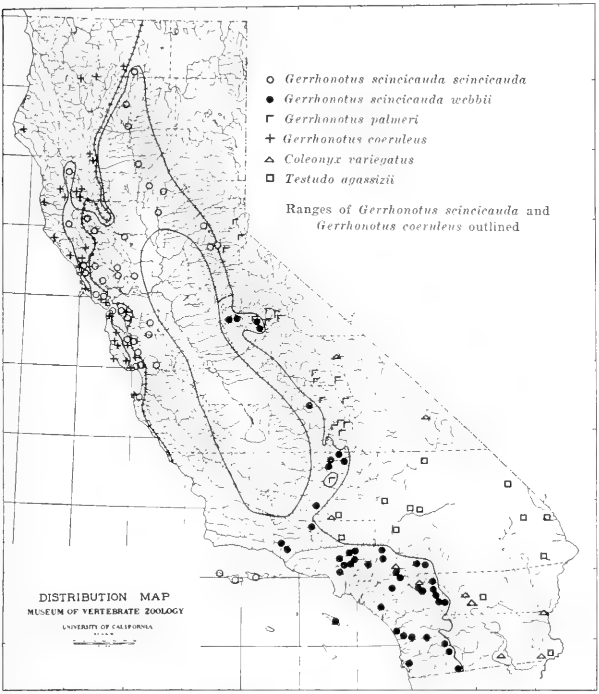

Fig. 9. Distribution of Alligator Lizards (*Gerrhonotus*), Gecko (*Coleonyx*), and Desert Tortoise (*Testudo agassizii*) in California.

Range.—West-central portion of the state. Extends south near the seacoast from Monte Rio, Sonoma County (Mus. Vert. Zool.) at least to Pacific Grove, Monterey County (Ven Denburgh, Occ. Papers Calif. Acad. Sci., **5**, 1897, p. 106). Extends north interiorly to Fairbanks (Van Denburgh, *loc. cit.*) and 3 miles west of Covelo (Mus.

Vert. Zool.), in Mendocino County, and to Squaw Creek, Siskiyou County (U. S. Nat. Mus.); southeast to Riverton, Eldorado County (Van Denburgh, *loc. cit.*). Supposed to intergrade on the southeast with *G. s. webbii.* Occurs also on San Miguel, Santa Rosa, and Santa Cruz islands (Van Denburgh, Proc. Calif. Acad. Sci., ser. 3, zool., **4**, 1905, pp. 3, 10–11, 12–13, 14). Occupies the Upper Sonoran life-zone, extending locally into Transition. Inhabits the chaparral. (See fig. 9.)

Gerrhonotus scincicauda webbii Baird

San Diego Alligator Lizard

Original Description.—*Gerrhonotus webbii* Baird, Proc. Acad. Nat. Sci. Phila., 1858 [1859], p. 255.

Type Locality.—Near San Diego, California.

Synonyms.—*Gerrhonotus scincicauda ignavus; Gerrhonotus scincicauda,* part; *Gerrhonotus multicarinatus,* part.

Common Names.—Many-keeled Lizard, part; Webb's Lizard.

Range.—Southern California, chiefly west of the desert divides and north along the lower west slopes of the Sierra Nevada as far as 3 miles northeast of Coulterville (3000 feet altitude), Mariposa County (Mus. Vert. Zool.); extends northwest at least to Matilija, Ventura County (Mus. Vert. Zool.). Easternmost stations: Jacumba, San Diego County (Cope, Ann. Rep. U. S. Nat. Mus., 1898 [1900], p. 525); Cabezon, Riverside County (Atsatt, Univ. Calif. Publ. Zool., **12**, 1913, pp. 38–39); Swartout Cañon, San Bernardino County (Van Denburgh, Proc. Calif. Acad. Sci., ser. 4, **3**, 1912, p. 148); and Onyx, Kern County (Mus. Vert. Zool.). Occurs also on Santa Catalina Island (Van Denburgh, Proc. Calif. Acad. Sci., ser. 4, **4**, 1914, pp. 132, 138). Occupies the Upper and Lower Sonoran life-zones, extending locally into Transition. Inhabits the chaparral; also occurs about buildings. (See fig. 9.)

Gerrhonotus palmeri Stejneger

Sierran Alligator Lizard

Original Description.—*Gerrhonotus scincicauda palmeri* Stejneger, N. Amer. Fauna, **7**, May 31, 1893, pp. 196–197.

Type Locality.—South Fork Kings River [in Fresno County], California.

Synonym.—*Gerrhonotus multicarinatus palmerii.*

Common Name.—Mountain Alligator Lizard.

Range.—Middle slopes of Sierra Nevada, from Tahoe City (Richardson, Proc. U. S. Nat. Mus., **48**, 1915, pp. 424–425) south to Jackass Meadow, 7750 feet altitude, Tulare County (Mus. Vert. Zool.). Highest altitude of capture, about 8800 feet (Stejneger, *loc. cit.*). Occurs also on Mount Breckenridge, 6500 feet altitude, Kern County (Mus. Vert. Zool.). Occupies the Canadian life-zone, extending into the Transition. Inhabits chaparral and underbrush on forest floors. (See fig. 9.)

Gerrhonotus coeruleus Wiegmann

Coast Alligator Lizard

Original Description.—*Gerrhonotus coeruleus* Wiegmann, Oken's Isis, 1828, **21**, pts. 3–4, p. 379.

Type Locality.—Brazil [= probably San Francisco: see Peters, *in* Duméril Bocourt, and Moquard, *in* Miss. Sci. au Mex., Recherch. Zool., pt. 3, sec. 1, 6ᵉ Livr., 1879, p. 355, and Stejneger, Proc. Biol. Soc. Wash., **15**, 1902, p. 37].

Synonyms.—*Gerrhonotus Burnettii* Gray, *in* Griffith's Animal King., **9**, 1831, Syn. Reptilia, p. 64 (from America [= California]); *Elgaria formosa* Baird and Girard, Proc. Acad. Nat. Sci. Phila., **6**, 1852, p. 175 (type from California); *Gerrhonotus grandis; Gerrhonotus multicarinatus,* part; *Gerrhonotus scincicaudus,* part.

Common Names.—Burnett's Alligator Lizard; Skink-tailed Lizard, part; Burnett's Keeled Lizard; Green-brown Lizard; Many-keeled Lizard, part.

Range.—A narrow coastwise strip, from Cuddeback, Humboldt County (Mus. Vert. Zool.) south to Pacific Grove, Monterey County (Van Denburgh, Occ. Papers Calif. Acad. Sci., **5**, 1897, p. 110). Occurs northeast to South Fork Salmon River, Siskiyou County (Mus. Vert. Zool.). Easternmost stations: 4 miles south of South Yolla Bolly Mountain, Tehama County; Lierly's, near Mount Sanhedrin, in Mendocino County; and Redwood Cañon, near Oakland, Alameda County (Mus. Vert. Zool.). Occupies the Transition life-zone. Inhabits chaparral and openings in forests; found frequently along streams. (See fig. 9.)

Family ANNIELLIDAE

Anniella pulchra pulchra Gray

Silvery Footless Lizard

Original Description.—*Anniella pulchra* Gray, Ann. Mag. Nat. Hist., ser. 2, **10**, 1852, p. 440.

Type Locality.—California.

Synonym.—*Anniella texana.*

Common Names.—Blue Worm-snake, part; Blind Worm; Worm Snake, part; Worm Lizard.

Range.—Chiefly southern coast district. Recorded north to Contra Costa County (Van Denburgh, Proc. Calif. Acad. Sci., ser. 3, zool., **4**, 1905, p. 48), and San Ardo, Monterey County (Van Denburgh, Occ. Papers Calif. Acad. Sci., **5**, 1897, pp. 117–118); east to Bear Valley, San Benito County (Van Denburgh, 1897, *loc. cit.*), Sequoia National Park, Tulare County, and between Oil City and Poso Creek, in Kern County (Van Denburgh, 1905, *loc. cit.*); to La Cañada, near Pasadena (Grinnell and Grinnell, Throop Inst. Bull., **35**, 1907, p. 33), San Bernardino and San Jacinto (Van Denburgh, 1897, *loc. cit.*), and La Puerta Valley, in eastern San Diego County (Mus. Vert. Zool.). Occurs within the Lower and Upper Sonoran life-zones. Inhabits sandy ground; lives beneath rocks in dry washes and in sand dunes.

Anniella pulchra nigra Fischer

Black Footless Lizard

Original Description.—*Anniella nigra* Fischer, Abh. Nat. Verein Hamburg, **9**, pt. 1, 1886, pp. 9–10, 1 pl.

Type Locality.—San Diego, California [more likely near Monterey; see Van Denburgh, Proc. Calif. Acad. Sci., ser. 3, zool., **4**, 1905, p. 45].

Synonym.—*Anniella pulchra,* part.

Common Name.—Blue Worm Snake, part.

Range.—Central seaboard. Recorded only from San Francisco (Cope, Ann. Rep. U. S. Nat. Mus., 1898 [1900], pp. 675, 676), vicinity of Monterey: Pacific Grove, Point Pinos, and Carmel Bay (Van Denburgh, *loc. cit.*, p. 48), and Marin County (Rivers, Bull. South. Calif. Acad. Sci., **1**, March, 1902, p. 27). Specimens examined by us (in Coll. San Diego Soc. Nat. Hist.) from Morro Bay, San Luis Obispo

County, are intermediate towards *pulchra,* but nearest *nigra.* Occurs within the Transition life-zone. Lives in sand dunes.

Family XANTUSIIDAE

Xantusia vigilis Baird

Desert Night Lizard

Original Description.—*Xantusia vigilis* Baird, Proc. Acad. Nat. Sci. Phila., 1858 [1859], p. 255.

Type Locality.—Fort Tejon, California [probably Antelope Valley, in northern Los Angeles County (see Grinnell and Grinnell, Throop Inst. Bull., **35**, 1907, p. 59)].

Common Name.—Xantus's Lizard.

Range.—Restricted to the tree yucca belt, chiefly on the Mohave Desert. Ranges north to east slope of Inyo Mountains, Inyo County (Meek, Field Columb. Mus., zool. ser., **7**, 1905 [1906], p. 13); west in vicinity of Walker Pass, Kern County, to Kelso Creek Valley, 3200 feet altitude, near Weldon (Mus. Vert. Zool.), to head of Piru Creek (Meek, *loc. cit.*) and Pallett (Mus. Vert. Zool.), in northern Los Angeles County, to Hesperia, San Bernardino County (Stejneger, N. Amer. Fauna, **7**, 1893, p. 198), and to Cabezon, Riverside County (Van Denburgh, Proc. Calif. Acad. Sci., ser. 2, **5**, 1895, p. 526); east to Goffs [Blake P. O.], San Bernardino County (Camp, Univ. Calif. Publ. Zool., **12**, 1916, p. 528). Occupies the Lower Sonoran life-zone. Lives in and beneath prostrate trunks of tree yuccas.

Xantusia henshawi Stejneger

Henshaw Night Lizard

Original Description.—*Xantusia henshawi* Stejneger, Proc. U. S. Nat. Mus., **16**, 1893 [1894], p. 467.

Type Locality.—Witch Creek, 2700 feet altitude, San Diego County, California.

Synonyms.—*Xantusia picta* Cope, Amer. Nat., **29**, 1895, pp. 859-860, 939 (type from "Tejon Pass"—almost certainly Poway, San Diego County: Van Denburgh, Copeia, no. 27, February 24, 1916, pp. 14–15); *Zablepsis henshawi.*

Common Names.—Henshaw's Lizard; Cope's Lizard.

Range.—Known only from eastern San Diego County, at the type locality as above, at Poway (Van Denburgh, *loc. cit.*), and in La

Puerta Valley (U. S. Nat. Mus.; Stephens, MS). Occurs in the Upper Sonoran life-zone. Lives in crevices of rock outcrops.

Xantusia riversiana Cope

Island Night Lizard

Original Description.—*Xantusia riversiana* Cope, Proc. Acad. Nat. Sci. Phila., 1883 [1884], pp. 29–32 (see also Amer. Nat., **13**, 1879, p. 801).

Type Locality.—California; fixed as San Nicolas Island, Ventura County, California, by Rivers (Amer. Nat., **23**, 1889, p. 1100).

Common Name.—Rivers's Lizard.

Range.—Known only from San Nicolas Island, Santa Barbara Island, and San Clemente Island. The record from Santa Catalina Island (Van Denburgh, Proc. Calif. Acad. Sci., ser. 3, zool., **4**, 1905, p. 16) is now questioned (Van Denburgh, Proc. Calif. Acad. Sci., ser. 4, **4**, 1914, p. 133). Lives beneath stones and in wind-drifted debris at bases of bushes.

Family TEIIDAE

Cnemidophorus tigris tigris Baird and Girard

Desert Whip-tailed Lizard

Original Description.—*Cnemidophorus tigris* Baird and Girard, Proc. Acad. Nat. Sci. Phila., **6**, 1852, p. 69.

Type Locality.—Valley of the Great Salt Lake, Utah.

Synonyms.—*Cnemidophorus gracilis* Baird and Girard, Proc. Acad. Nat. Sci. Phila., **6**, 1852, p. 128 (type from desert of Colorado); *Cnemidophorus tessellatus tigris*, part; *Cnemidophorus tessellatus tessellatus*, part; *Cnemidophorus sexlineatus* var. *tesselatus; Cnemidophorus sexlineatus* var. *bocourtii* Boulenger, Cat. Lizards Brit. Mus., 2nd ed., **2**, 1885, p. 367 (types from California).

Common Names.—Desert Whip-tail; Swift Jack; Tessellated Lizard; Tiger Armor-bearer; Tiger Lizard.

Range.—Deserts of southeastern California. Extends north to Benton, Mono County (Mus. Vert. Zool.); west to Gray's (altitude 6000 feet, near Kearsarge Pass) and Carroll Creek, in Inyo County (Mus. Vert. Zool.), and to desert bases of San Gabriel, San Bernardino, San Jacinto and other mountain ranges to the southward. Intergrades with *C. t. mundus* through Walker Pass, and with *C. t. stejnegeri* in

Antelope Valley, Los Angeles County, around the northeast base of the San Jacinto Mountains, and east of the desert divides in western Imperial County (Mus. Vert. Zool.). Occupies the Lower Sonoran life-zone. Inhabits sandy or gravelly ground both among rocks and bushes and in open country. (See fig. 10.)

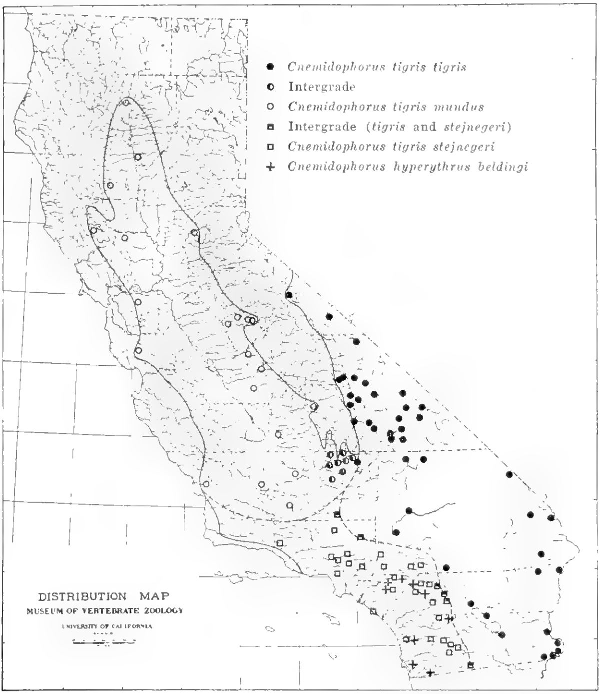

Fig. 10. Distribution of Whip-tailed Lizards (*Cnemidophorus*) in California.

Cnemidophorus tigris mundus Camp

California Whip-tailed Lizard

Original Description.—*Cnemidophorus tigris mundus* Camp, Univ. Calif. Publ. Zool., **17**, December 28, 1916, p. 71 (new name to replace *Cnemidophorus undulatus* Hallowell, Proc. Acad. Nat. Sci. Phila., **7**, 1854, p. 94).

Type Locality.—Fort Yuma, in San Joachim Valley; later corrected to Fort Miller, Fresno County, California (Stejneger, N. Amer. Fauna, **7**, 1893, p. 201).

Synonyms.—*Cnemidophorus tessellatus tigris,* part; *Cnemidophorus tessellatus tessellatus,* part; *Cnemidophorus tigris undulatus,* part.

Common Names.—California Whip-tail; Tessellated Tiger Lizard.

Range.—Sacramento and San Joaquin valleys and adjacent mountain slopes and detached valleys. Occurs north as far as McCloud River, in Shasta County (Cope, Ann. Rep. U. S. Nat. Mus., 1898 [1900], p. 579); west to Winslow, Glenn County (Mus. Vert. Zool.), to Kelseyville, Lake County (Van Denburgh, Occ. Papers Calif. Acad. Sci., **5**, 1897, p. 138), to Mount Diablo, Contra Costa County (Mus. Vert. Zool.), to Los Gatos, Santa Clara County (Van Denburgh, *loc. cit.*), to Carmel Valley, Monterey County (McLain, Crit. Notes Coll. Reptiles Western U. S., 1899, p. 9), and to Santa Margarita, San Luis Obispo County (Mus. Vert. Zool.); south to Walker, Tehachapi, and Tejon passes, in Kern and Los Angeles counties; east to Coulterville road near Big Meadow, 4000 feet altitude, in Mariposa County (Storer, MS), and to Raymond, Madera County (Mus. Vert. Zool.). Probably intergrades on the south with *C. t. stejnegeri.* Occupies the Lower and Upper Sonoran life-zones. Usual habitat, open valley floors; also lives amid sparse chaparral on hillsides. (See fig. 10.)

Cnemidophorus tigris stejnegeri Van Denburgh

Stejneger Whip-tailed Lizard

Original Description.—*Cnemidophorus stejnegeri* Van Denburgh, Proc. Calif. Acad. Sci., ser. 2, **4**, July 12, 1894, pp. 300–301.

Type Locality.—Between San Rafael and Ensenada, Lower California, Mexico.

Synonyms.—*Cnemidophorus grahamii stejnegerii; Cnemidophorus tessellatus tessellatus,* part; *Cnemidophorus grahamii; Cnemidophorus tigris undulatus,* part.

Common Names.—Graham's Striped Lizard; Stejneger's Whiptail.

Range.—Chiefly Pacific slope of southern California. Occurs north to Matilija, Ventura County (Mus. Vert. Zool.); east to San Gabriel Mountains, up to 5900 feet altitude, in Los Angeles County (Camp, MS), to Lytle Creek (Van Denburgh, Occ. Papers Calif.

Acad. Sci., **5**, 1897, p. 140) and Upper Santa Ana Cañon, 5500 feet altitude (Grinnell, Univ. Calif. Publ. Zool., **5**, 1908, p. 163), in San Bernardino County, to San Jacinto and Santa Rosa mountains, Riverside County (Atsatt, Univ. Calif. Publ. Zool., **12**, 1913, pp. 39–40), and to Vallecito, in eastern San Diego County (Mus. Vert. Zool.). Occupies the Lower and Upper Sonoran life-zones. Inhabits washes, gravelly mesas, and dry mountain slopes. (See fig. 10.)

Cnemidophorus hyperythrus beldingi (Stejneger)

Belding Orange-throated Lizard

Original Description.—*Verticaria beldingi* Stejneger, Proc. U. S. Nat. Mus., **17**, 1894 [1895], pp. 17–18.

Type Locality.—Cerros Island, Lower California, Mexico.

Synonyms.—*Verticaria hyperythra; Cnemidophorus hyperythrus; Verticaria hyperythra beldingi.*

Common Names.—Belding's Orange-throat; Cape Striped Lizard.

Range.—Foothill districts of western San Diego and Riverside counties. Occurs north to Reche Cañon, Riverside County (Atsatt, Univ. Calif. Publ. Zool., **12**, 1913, p. 40); west to Temescal Mountains, Riverside County (Van Denburgh, Proc. Calif. Acad. Sci., ser. 4, **3**, 1912, p. 150), and to Escondido (Mus. Vert. Zool.) and San Diego (Cope, Ann. Rep. U. S. Nat. Mus., 1898 [1900], p. 564), in San Diego County; east to Oak Grove, San Diego County (Van Denburgh, *loc. cit.*, p. 152), and San Jacinto, Riverside County (Stejneger, *loc. cit.*). Occurs within the Lower Sonoran life-zone. Inhabits dry, sparsely vegetated, sandy ground, and dusty roadsides. (See fig. 10.)

Family SCINCIDAE

Plestiodon skiltonianum Baird and Girard

Western Skink

Original Description.—*Plestiodon Skiltonianum* Baird and Girard, Proc. Acad. Nat. Sci. Phila., **6**, 1852, p. 69.

Type Locality.—Oregon.

Synonyms.—*Eumeces quadrilineatu*[*s*] Hallowell, Pac. R. R. Rep., **10**, 1859, Williamson's Rep., pt. 4, no. 1, p. 10 (types from near Mohave River and in San Bernardino Valley [more likely the latter]); *Eumeces gilberti* Van Denburgh, Proc. Calif. Acad. Sci., ser. 2, **6**, 1896, pp. 350–352 (type from Yosemite Valley, Mariposa County [see Camp, Univ. Calif. Publ. Zool., **17**, 1916, pp. 72–73]); *Eumeces skiltonianus* var. *brevipes* Cope, Ann. Rep. U. S. Nat. Mus., 1898 [1900], pp. 643-644 (type from Fresno); *Eumeces hallowellii* Bocourt, *in* Duméril, Bocourt, and Moquard, *in* Miss. Sci. au Mex., Recherch. Zool., pt. 3, sec. 1, 6e livr., 1879, p. 435, Atlas, [1881], pl. 22E, fig. 7 (type from California); *Eumeces skiltonianus* var. *amblygrammus* Cope, *loc. cit.*, p. 643 (type from Fort Humboldt); *Eumeces skiltonianus.*

Common Names.—Blue-tailed Lizard; Skilton's Skink; Red-headed Skink; Gilbert's Skink; Blue-tailed Skink.

Range.—Nearly the entire state; absent on the southeastern deserts and on the Sierra Nevada above 8000 feet altitude. Occurs east to head of Willow Creek, 7000 feet altitude, Panamint Mountains, Inyo County (Stejneger, N. Amer. Fauna, **7**, 1893, p. 202); southeast to Maturango Spring, Argus Range, Inyo County (Stejneger, *loc. cit.*); to Kern River near Isabella (Mus. Vert. Zool.) and old Fort Tejon (Stejneger, *loc. cit.*), in Kern County; to Barley Flats, 5500 feet altitude, San Gabriel Mountains, Los Angeles County (Mus. Vert. Zool.); to Bluff Lake, San Bernardino Mountains, San Bernardino County (Van Denburgh, Proc. Calif. Acad. Sci., ser. 4, **3**, 1912, p. 149); to Strawberry Valley, 5500 feet altitude, San Jacinto Mountains, Riverside County (Atsatt, Univ. Calif. Publ. Zool., **12**, 1913, p. 41); and to Jacumba Hot Springs, San Diego County (Cope, Ann. Rep. U. S. Nat. Mus., 1898 [1900], p. 644). Occurs also on Santa Catalina Island (Van Denburgh, Proc. Calif. Acad. Sci., ser. 4, **4**, 1914, pp. 132, 138). Inhabits chiefly the Upper Sonoran life-zone, but extends also through Transition. Characteristic habitat, rocky or wooded hillsides and cañon bottoms; lives beneath stones and masses of dead vegetation.

Suborder SERPENTES

Family LEPTOTYPHLOPIDAE

Leptotyphlops humilis (Baird and Girard)

Worm Snake

Original Description.—*Rena humilis* Baird and Girard, Cat. N. A. Reptiles in Smiths. Inst., pt. 1, 1853, p. 143.

Type Locality.—Valliecitas [= Vallecito, San Diego County], California.

Synonyms.—[?] *Ophisaurus ventralis; Glauconia humilis; Stenostoma humile; Siagonodon humilis.*

Common Names.—California Rena; California Blind Snake; Glass Snake; Sheep-nosed Snake.

Range.—The three definite records are from southeastern California: six miles from Bennett Wells, in Death Valley, Inyo County (Stejneger, N. Amer. Fauna, **7**, 1893, p. 203); San Bernardino, San Bernardino County (Boulenger, Cat. Snakes Brit. Mus., **3**, 1896, p. 591); and the type locality, in extreme eastern San Diego County, as above. These localities lie within the Lower Sonoran life-zone.

Family BOIDAE

Subfamily Boinae

Lichanura roseofusca Cope

California Boa

Original Description.—*Lichanura roseofusca* Cope, Proc. Acad. Nat. Sci. Phila., 1868, p. 2.

Type Locality.—Northern Lower California, Mexico.

Synonyms.—*Lichanura orcutti* Stejneger, Proc. U. S. Nat. Mus., **12**, 1889, pp. 96–97, fig. 1 (type from Colorado Desert, San Diego County); *Lichanura simplex* Stejneger, *loc. cit.*, pp. 97–99, fig. 2 (type from San Diego); *Lichanura myriolepis; Lichanura trivirgata.*

Common Names.—Rubber Snake, part; Rubber Boa, part; Rosy Boa.

Range.—Limited to a small area in the southern part of the state. Recorded northwest to Arroyo Seco (Camp, MS) and Mount Wilson (Van Denburgh, Occ. Papers Calif. Acad. Sci., **5**, 1897, p. 154) near Pasadena, Los Angeles County; east to Cabezon and Palm Cañon, Riverside County (Atsatt, Univ. Calif. Publ. Zool., **12**, 1913, p. 41), and to Dulzura (Mus. Vert. Zool.) and "Colorado Desert" (as above), San Diego County. There is a specimen in the U. S. National Museum (no. 44317) from the Providence Mountains, northeastern San Bernardino County. Occurs within the Lower and Upper Sonoran life-zones. Lives on shaded hillsides in dense chaparral. (See fig. 11.)

Charina bottae (Blainville)

Rubber Snake

Original Description.—*Tortrix Bottae* Blainville, Nouv. Ann. Mus. Hist. Nat., **4**, 1835, pp. [57–58] 289–290, pl. 26, figs. 1, 1*a*, 1*b*.

Type Locality.—California [Monterey?].

Synonyms.—*Charina brachyops* Cope, Proc. U. S. Nat. Mus., **11**, 1888, p. 88 (type from Point Reyes, Marin County); *Charina plumbea; Pseudocryx bottae.*

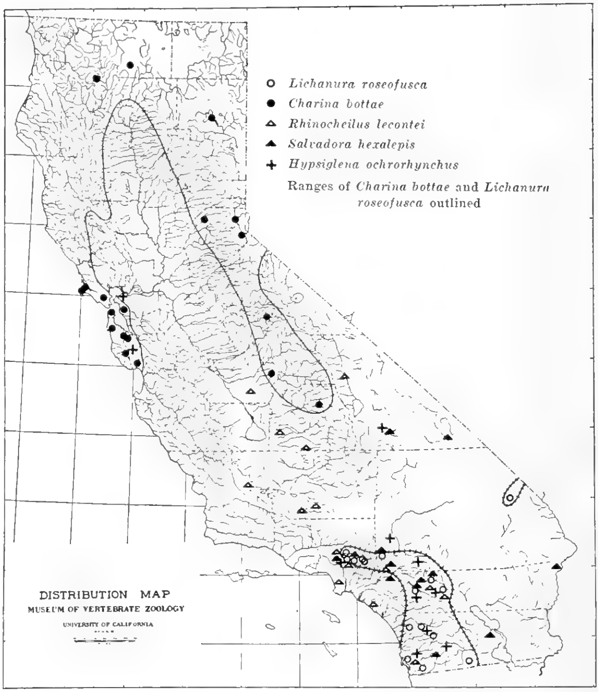

Fig. 11. Distribution of Snakes (*Lichanura, Charina, Rhinocheilus, Salvadora,* and *Hypsiglena*) in California.

Common Names.—Two-headed Snake; Lead-colored Worm Snake; Wood Snake; Rubber Boa, part.

Range.—Northern California, both east and west of the Sierra Nevada. Has been found south to Redwood Cañon, East Fork Kaweah River, Tulare County (Stejneger, N. Amer. Fauna, **7**, 1893, p. 203), and to Soquel, Santa Cruz County (Van Denburgh, Occ. Papers Calif. Acad. Sci., **5**, 1897, p. 156). Southeasternmost stations are: Tahoe City, Placer County (Van Denburgh, *loc. cit.*), and Yosemite Valley, Mariposa County (Mus. Vert. Zool.). Occurs chiefly within the Transition life-zone, extending locally into Upper Sonoran. Inhabits damp ground in cañons and on forest floors. (See fig. 11.)

Superfamily COLUBROIDEAE
Family COLUBRIDAE
Subfamily Natricinae

Thamnophis marcianus (Baird and Girard)

Marcy Garter Snake

Original Description.—*Eutainia Marciana* Baird and Girard, Cat. N. A. Reptiles in Smiths. Inst., pt. 1, 1853, pp. 36–37.

Type Locality.—Red River, Arkansas [= near Cache Creek, Oklahoma: Ruthven, U. S. Nat. Mus. Bull., **61**, 1908, p. 58].

Synonym.—*Eutaenia elegans marciana.*

Range.—Along the lower Colorado River from Fort Yuma, Imperial County (Yarrow, U. S. Nat. Mus. Bull., **24**, 1882, pp. 17, 118) north at least to Riverside Mountain, Riverside County (Mus. Vert. Zool.). Life-zone, Lower Sonoran. Habitat, riparian.

Thamnophis ordinoides ordinoides (Baird and Girard)

Pacific Coast Garter Snake

Original Description.—*Tropidonotus ordinoides* Baird and Girard, Proc. Acad. Nat. Sci. Phila., **6**, 1852, p. 176.

Type Locality.—Puget Sound.

Synonyms.—*Eutaenia leptocephala; Eutaenia infernalis vidua* Cope, Proc. U. S. Nat. Mus., **14**, 1891, pp. 658–659 (types from San Francisco); *Eutainia atrata* Kennicott, *in* Cooper, Pac. R. R. Rep., **12**, 1859, pt. 3, no. 4, p. 296 (type from California); *Eutaenia elegans*, part; *Eutaenia infernalis*, part; *Eutaenia elegans ordinoides; Tropidonotus leptocephalus; Eutaenia sirtalis leptocephala; Eutaenia ordinoides; Thamnophis infernalis*, part; *Eutainia sirtalis elegans; Thamnophis leptocephala.*

Common Names.—Puget Garter Snake; Narrow-headed Garter Snake; Black Garter Snake; Boyd's Garter Snake, part.

Range.—Chiefly the narrow northwest coast strip within twenty miles of the seacoast; authentically recorded south as far as Monterey (Ruthven, U. S. Nat. Mus. Bull., **61**, 1908, p. 149). One interior record: Fresno (Ruthven, *loc. cit.*). Occupies the Transition life-zone. Lives in dense vegetation, along streams and on marshy ground.

Thamnophis ordinoides elegans (Baird and Girard)

Elegant Garter Snake

Original Description.—*Eutainia elegans* Baird and Girard, Cat. N. A. Reptiles in Smiths. Inst., pt. 1, 1853, pp. 34–35.

Type Locality.—Eldorado County, California.

Synonyms.—*Eutainia vagrans* Baird and Girard, *loc. cit.*, pp. 35-36 (types from Humboldt River); *Eutaenia infernalis,* part; *Eutaenia elegans lineolata* Cope, Proc. U. S. Nat. Mus., **14**, 1891, p. 655 (type from southern California: see Cope, Ann. Rep. U. S. Nat. Mus., 1898 [1900], p. 1039); *Eutaenia elegans brunnea* Cope, Proc. U. S. Nat. Mus., **14**, 1891, p. 654 (type from Fort Bidwell, Modoc County); *Eutaenia couchii* Kennicott, *in* Baird, Pac. R. R. Rep., **10**, 1859, Abbot's Rep., pt. 4, no. 4, pp. 10–11 (type from bank of Pit River); *Thamnophis infernalis,* part; *Tropidonotus tri-vittatus* Hallowell, Proc. Acad. Nat. Sci. Phila., **6**, 1853, p. 237 (types from banks of Cosumnes and other rivers in California); *Eutaenia elegans couchii,* part; *Tropidonotus ordinatus infernalis; Tropidonotus ordinatus* var. *couchii; Thamnophis vagrans; Thamnophis parietalis,* part; *Eutaenia elegans vagrans; Eutaenia hammondi,* part; *Thamnophis elegans,* part; *Eutaenia elegans infernalis.*

Common Names.—Boyd's Garter Snake, part; Pacific Garter Snake, part; Wandering Garter Snake; Hammond's Garter Snake, part; Single-striped Garter Snake; Green Garter Snake; Western Garter Snake, part.

Range.—Northeastern portion of the state; across the head of the Sacramento Valley and reaching in that latitude as far as Humboldt Bay; south along the Sierra Nevada to Lone Pine, Inyo County, and Kern River, in Kern County, and thence west through the mountains about the head of the San Joaquin Valley to the seacoast from Santa Ynez River, Santa Barbara County (Mus. Vert. Zool.), north to Morro, San Luis Obispo County (Ruthven, U. S. Nat. Mus. Bull., **61**, 1908, pp. 140–141). Thought to intergrade along the western edge of its range with *ordinoides* and at the south with *hammondii.* Occurs within the Canadian and Transition life-zones, extending locally into Upper Sonoran. Inhabits marshes, stream-sides, and ponds.

Thamnophis ordinoides hammondii (Kennicott)

California Garter Snake

Original Description.—*Eutaenia Hammondii* Kennicott, Proc. Acad. Nat. Sci. Phila., 1860 [1861], p. 332.

Type Locality.—San Diego, California.

Synonyms.—*Eutaenia couchii,* part; *Eutaenia elegans couchii,* part; *Tropidonotus ordinatus* var. *hammondii; Tropidonotus ordinatus; Eutaenia marciana,* part; *Tropidonotus vagrans.*

Common Names.—Hammond's Garter Snake, part; Water Snake; Couch's Garter Snake; Marcy's Garter Snake, part.

Range.—The southwestern portion of the state, chiefly in mountains west of the desert divides. Recorded north to Lone Pine, Inyo County (U. S. Nat. Mus.), to Kernville, Kern County, and vicinity of Fresno (Ruthven, U. S. Nat. Mus. Bull., **61**, 1908, p. 135). Easternmost stations are: Laguna Mountains, San Diego County (Cope, Ann. Rep. U. S. Nat. Mus., 1898 [1900], p. 1044); Palm Cañon, 800 feet altitude, San Jacinto Mountains (Atsatt, Univ. Calif. Publ. Zool., **12**, 1913, p. 43); Bluff Lake, 7500 feet altitude, San Bernardino Mountains (Mus. Vert. Zool.); and Mohave River at Victorville (Mus. Vert. Zool.). Occupies the Upper Sonoran and Transition life-zones. Inhabits streams and margins of lakes and the near vicinity of same.

Thamnophis sirtalis parietalis (Say)

Western Garter Snake

Original Description.—*Coluber parietalis* Say, *in* Long, Exped. to Rocky Mountains, **1**, 1823, pp. 186–187, footnote.

Type Locality.—Camp Missouri [near Council Bluffs, Iowa].

Synonyms.—*Coluber infernalis* Blainville, Nouv. Ann. Mus. Nat. Hist., **4**, 1835, pp. [59–60] 291–292, pl. 26, figs. 3–3*a* (type from California); *Eutaenia sirtalis obscura; Eutaenia sirtalis; Tropidonotus parietalis; Eutaenia proxima; Eutaenia imperialis* (type said to be from Tomales Bay: Coues and Yarrow, Bull. U. S. Geol. Surv. Terr., **4**, 1878, p. 280); *Eutaenia sirtalis pickeringii; Thamnophis infernalis,* part; *Thamnophis elegans,* part; *Eutaenia concinna; Thamnophis parietalis; Eutaenia sirtalis parietalis; Eutaenia sirtalis tetrataenia; Eutaenia sirtalis dorsalis.*

Common Names.—Pacific Garter Snake, part; Rocky Mountain Garter Snake; Red-barred Garter Snake; California Garter Snake, part; Churchill's Garter Snake; Dusky Garter Snake; Say's Garter Snake; Striped Snake; Pickering's Garter Snake.

RANGE.—Almost throughout the state west and north of the southeastern deserts. Recorded southeast to Yosemite Valley, Mariposa County (Van Denburgh, Occ. Papers Calif. Acad. Sci., **5**, 1897, p. 203), to Kern River, in Kern County (Mus. Vert. Zool.), and to Riverside, Riverside County (Van Denburgh, *loc. cit.*). Southernmost station, Bixby, near Long Beach, Los Angeles County (Grinnell and Grinnell, Throop Inst. Bull., **35**, 1907, pp. 48–49). Occupies the Lower and Upper Sonoran and Transition life-zones. Lives along streams, sloughs, and lake-margins, and in wet meadows.

Subfamily COLUBRINAE

Chilomeniscus cinctus Cope

Banded Burrowing Snake

ORIGINAL DESCRIPTION.—*Chilomeniscus cinctus* Cope, Proc. Acad. Nat. Sci. Phila., 1861, p. 303.

TYPE LOCALITY.—Near Guaymas, east coast of Gulf of California, Mexico.

SYNONYM.—*Chilomeniscus ephippicus* Cope, Proc. Acad. Nat. Sci. Phila., 1867, p. 85 (type from Owens Valley, Inyo County).

COMMON NAMES.—Horse Snake; Red and Black Ground Snake.

RANGE.—Only two records, both from the southeastern deserts: from the type locality of *ephippicus*, as above, and from Fort Yuma, Imperial County (Van Denburgh and Slevin, Proc. Calif. Acad. Sci., ser. 4, **3**, 1913, p. 410). Life-zone, Lower Sonoran. (See fig. 12.)

Sonora occipitalis (Hallowell)

Desert Burrowing Snake

ORIGINAL DESCRIPTION.—*Rhinostoma occipitale* Hallowell, Proc. Acad. Nat. Sci. Phila., **7**, 1854, p. 95.

TYPE LOCALITY.—Mohave Desert, California.

SYNONYMS.—*Lamprosoma annulatum* Baird, U. S. Mex. Bound. Surv., **2**, 1859, pt. 2, Reptiles, p. 22, pl. 21, fig. 1 (types from Colorado Desert); *Lamprosoma occipitale; Chionactis occipitalis; Chionactis occipitalis annulatus.*

COMMON NAMES.—Desert Snake; Mohave Ringed Snake.

Range.—Mohave and Colorado deserts, north to Owens Lake, Inyo County (Meek, Field Columb. Mus., zool. ser., **7**, 1906, p. 15), and Blythe Junction, San Bernardino County (Camp, Univ. Calif. Publ. Zool., **12**, 1916, p. 531), and west to Carrizo Creek and La Puerta Valley, in eastern San Diego County (Mus. Vert. Zool.). Restricted to the Lower Sonoran life-zone. Inhabits open gravelly or sandy ground. (See fig. 12.)

Sonora episcopa (Kennicott)

Texas Ground Snake

Original Description.—*Lamprosoma episcopum* Kennicott, *in* Baird, U. S. Mex. Bound. Surv., **2**, 1859, pt. 2, Reptiles, p. 22, pl. 8, fig. 2.

Type Locality.—Eagle Pass, Texas.

Range.—Extreme southeastern deserts; two instances of occurrence: 4 miles north of Blythe Junction, San Bernardino County (Camp, Univ. Calif. Publ. Zool., **12**, 1916, pp. 530–531); Heber, Imperial County (no. 5610, Mus. Vert. Zool.). Both localities lie within the Lower Sonoran life-zone. In the first case, the snake was taken from beneath a stone on a rocky hillside. (See fig. 12.)

Contia mitis Baird and Girard

Sharp-tailed Snake

Original Description.—*Contia mitis* Baird and Girard, Cat. N. A. Reptiles in Smiths. Inst., pt. 1, 1853, pp. 110–111.

Type Locality.—San Jose, Santa Clara County, California.

Synonyms.—*Ablabes purpureocauda* Günther, Cat. Colubrine Snakes Brit. Mus., 1858, p. 245 (type from California); *Homalosoma mite.*

Common Names.—Purple-tailed Snake; Pacific Ground Snake; Brown Snake; Gentle Brown Snake.

Range.—Northern portion of the state, mostly near the seacoast. Southernmost stations: Big Basin, Santa Cruz County (Van Denburgh, Occ. Papers Calif. Acad. Sci., **5**, 1897, p. 163), and [near] Fresno, Fresno County (Yarrow, U. S. Nat. Mus. Bull., **24**, 1882, pp. 14, 87); easternmost stations: Fyffe, Eldorado County (Van Denburgh, *loc. cit.*), and Baird, Shasta County (Cope, Ann. Rep. U. S. Nat. Mus., 1898 [1900], p. 926). Occurs in the Transition and Upper Sonoran life-zones. Lives beneath stones in hilly country. (See fig. 12.)

Diadophis amabilis Baird and Girard

Western Ring-necked Snake

Original Description.—*Diadophis amabilis* Baird and Girard, Cat. N. A. Reptiles in Smiths. Inst., pt. 1, 1853, pp. 113–114.

Type Locality.—San Jose, Santa Clara County, California.

Synonyms.—*Diadophis pulchellus* Baird and Girard, *loc. cit.*, p. 115 (type from Eldorado County); *Diadophis punctatus pulchellus; Diadophis punctatus amabilis; Diadophis amabilis pulchellus; Coronella amabilis; Ablabes punctatus;* [?] *Coluber punctatus; Diadophis punctatus.*

Common Names.—California Ring-necked Snake; Red-bellied Snake; Spotted Ring Snake.

Range.—West of the desert divides the whole length of the state. Occurs northeast to McCloud River, Shasta County (Townsend, Proc. U. S. Nat. Mus., **10**, 1887, p. 239); east to Oroville, Butte County (Mus. Vert. Zool.); to Eldorado County (as above); to Yosemite Valley, Mariposa County (Stejneger, N. Amer. Fauna, **7**, 1893, p. 204); to [near] Fresno, Fresno County (Yarrow, U. S. Nat. Mus. Bull., **24**, 1882, pp. 15, 95–96); to Tejon Pass [Kern County?] (Heermann, Pac. R. R. Rep., **10**, 1859, Williamson's Rep., pt. 4, no. 1, p. 24); to Arroyo Seco Cañon (Grinnell and Grinnell, Throop Inst. Bull., **35**, 1907, pp. 38–39) and Glendora (Mus. Vert. Zool.), Los Angeles County; to Santa Ana Cañon, 6400 feet altitude, San Bernardino County (Grinnell, Univ. Calif. Publ. Zool., **5**, 1908, p. 164); to Strawberry Valley, 5500 feet altitude, San Jacinto Mountains, Riverside County (Atsatt, Univ. Calif. Publ. Zool., **12**, 1913, p. 41); and to Witch Creek, San Diego County (Cope, Ann. Rep. U. S. Nat. Mus., 1898 [1900], p. 749). There is a mutilated specimen of a *Diadophis* in the U. S. National Museum from Santa Catalina Island. Occurs within the Upper Sonoran and Transition life-zones. Inhabits shaded cañons; lives in masses of dead leaves and beneath stones. (See fig. 12.)

Lampropeltis pyromelana multicincta (Yarrow)

Coral King Snake

Original Description.—*Ophibolus getulus multicinctus* Yarrow, Proc. U. S. Nat. Mus., **5**, 1882, p. 440.

Type Locality.—[Near] Fresno, California.

Synonyms.—[?] *Coluber (Zacholus) zonatus* Blainville, Nouv.

Ann. Mus. Nat. Hist., **4**, 1835, pp. [61–62] 293–294 (type from California); *Coronella multifasciata* Bocourt, *in* Duméril, Bocourt, and Moquard, *in* Miss. Sci. au Mex., Recherch. Zool., pt. 3, sec. 1, 10^e, livr. 1886, pp. 616–617, Atlas, pl. 40, figs. 2–2*c* (type from California);

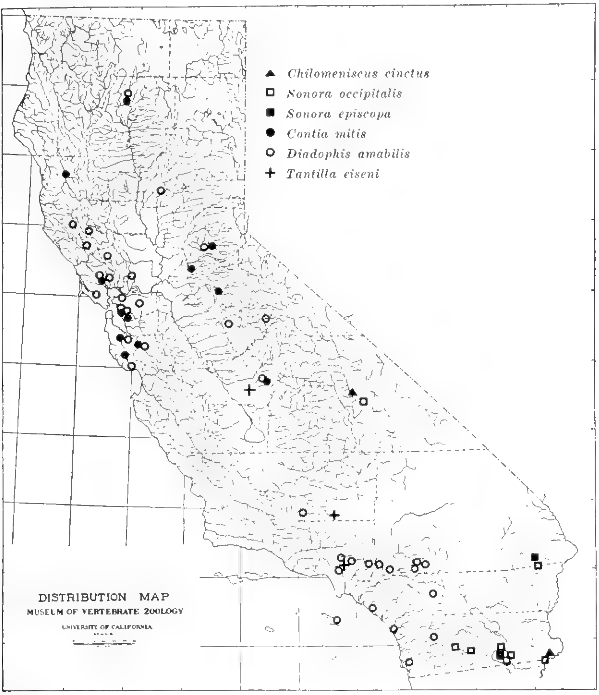

Fig. 12. Distribution of Snakes (*Diadophis, Tantilla, Chilomeniscus, Sonora,* and *Contia*) in California.

Bellophis zonatus Lockington, Proc. Calif. Acad. Sci., **7**, 1876 [1877], pp. 52–53 (type from "Northern California": Santa Barbara, according to Van Denburgh, Occ. Papers Calif. Acad. Sci., **5**, 1897, p. 167); *Ophibolus pyrrhomelanus; Ophibolus pyrrhomelas; Coronella pyromelanus zonata; Coronella zonata; Ophibolus zonatus; Lampropeltis zonata.*

Common Names.—California King Snake; Arizona Ringed Snake; Ringed King Snake; Eisen's King Snake; Red Milk Snake; Corral Snake; Ring Snake; Harlequin Snake.

Range.—The southwestern portion of the state, altogether west of the desert divides. Occurs north in the coast belt as far as Glenwood, Santa Cruz County, and Mount Hamilton, Santa Clara County (Van Denburgh, *loc. cit.*, p. 169), and on the west slope of the Sierra Nevada to Riverton, Eldorado County (Van Denburgh, *loc. cit.*); east to Yosemite Valley, Mariposa County (Van Denburgh, *loc. cit.*); to Heaven's Gate, near Little Kern Lake, Tulare County (Van Denburgh, *loc. cit.*); to Arroyo Seco Cañon, near Pasadena, Los Angeles County (Mus. Vert. Zool.); to upper Santa Ana Cañon, 5500 feet altitude, San Bernardino County (Grinnell, Univ. Calif. Publ. Zool., **5**, 1908, p. 165); and to Strawberry Valley, 6000 feet altitude, Riverside County (Atsatt, Univ. Calif. Publ. Zool., **12**, 1913, pp. 41–42). Extends south as far as vicinity of San Diego (Van Denburgh, *loc. cit.*). Occurs chiefly within the Transition life-zone, entering to some extent the Upper Sonoran. Inhabits forest floors and chaparral-covered hillsides.

Lampropeltis boylii (Baird and Girard)

Boyle King Snake

Original Description.—*Ophibolus Boylii* Baird and Girard, Cat. N. A. Reptiles in Smiths. Inst., pt. 1, 1853, pp. 82–83.

Type Locality.—Eldorado County, California.

Synonyms.—*Coronella balteata* Hallowell, Proc. Acad. Nat. Sci. Phila., **6**, 1853, pp. 236–237 (types from California); *Ophibolus getulus boylii*, part; *Coronella getula*, part; *Coronella boylii*.

Common Names.—Boyle Milk Snake; California King Snake, part; California Milk Snake, part; Banded Milk Snake.

Range.—Throughout the southern and central parts of the state, except on the high mountains (above 6000 feet altitude) and along the lower Colorado River. Occurs north in the coast belt at least to near Cazadero, Sonoma County (Mus. Vert. Zool.), in the interior to Lierly's, near Mount Sanhedrin, Mendocino County (Mus. Vert. Zool.), to McCloud River, Shasta County (Townsend, Proc. U. S. Nat. Mus., **10**, 1887, p. 239), and to Applegate, Placer County (Van Denburgh, Occ. Papers Calif. Acad. Sci., **5**, 1897, p. 171), and, east of the Sierran divide, to Beveridge Cañon (on east slope of Inyo Mountains) and

Wild Rose Springs, in Inyo County (Meek, Field Columb. Mus., zool. ser., **7**, 1905 [1906], p. 15). There is a specimen in the U. S. National Museum from Avalon, Santa Catalina Island [see also Cooper, Proc. Calif. Acad. Sci., **4**, 1870, p. 79]. Occurs in the Lower and Upper Sonoran and Transition life-zones. Shows no special restriction in habitat.

Lampropeltis conjuncta Cope

Black King Snake

Original Description.—*Lampropeltis boylii* var. *conjuncta* Cope, Proc. Acad. Nat. Sci. Phila., 1861, pp. 301–302.

Type Locality.—Cape San Lucas [Lower California, Mexico].

Synonym.—*Ophibolus getulus boylii*, part.

Common Name.—California King Snake, part.

Range.—Colorado River bottom. Has been taken near Pilot Knob and 5 miles northeast of Fort Yuma (nos. 1837 and 1838, Mus. Vert. Zool.), and at Fort Yuma (Cope, *loc. cit.*). These stations are all in Imperial County and lie within the Lower Sonoran life-zone.

Lampropeltis californiae (Blainville)

California King Snake

Original Description.—*Coluber (Ophis) Californiae* Blainville, Nouv. Ann. Mus. Nat. Hist., **4**, 1835, p. [60] 292, pl. 27, figs. 1, 1*a*, 1*b*.

Type Locality.—California.

Synonyms.—*Ophibolus getulus eiseni* Yarrow, Proc. U. S. Nat. Mus., **5**, 1882, pp. 439–440 (types from Fresno, California); *Ophibolus getulus californiae; Ophibolus californiae; Coronella Californiae; Coronella getula*, part; *Coronella getulus* var. *californica.*

Common Names.—Blainville's King Snake; California Milk Snake, part.

Range.—Interruptedly distributed through the southern part of the state west of the desert divides. Localities of occurrence are: Fresno (as above); Waterman Cañon, San Bernardino County (Van Denburgh, Proc. Calif. Acad. Sci., ser. 4, **3**, 1912, p. 149); Riverside County (Van Denburgh, Occ. Papers Calif. Acad. Sci., **5**, 1897, p. 174); Cuyamaca (Van Denburgh, 1912, *loc. cit.*, p. 151), Witch Creek (Cope, Ann. Rep. U. S. Nat. Mus., 1898 [1900], p. 923), Dulzura and Julian (Mus. Vert. Zool.), in San Diego County. Occurs in the Upper, and possibly also the Lower, Sonoran life-zone.

Rhinocheilus lecontei Baird and Girard

Long-nosed Snake

Original Description.—*Rhinocheilus Lecontei* Baird and Girard, Cat. N. A. Reptiles in Smiths. Inst., pt. 1, 1853, pp. 120–121.

Type Locality.—San Diego, California.

Common Name.—Leconte's Snake.

Range.—Chiefly Pacific slope of southern California and floor of San Joaquin Valley. Has been found northwest to Carrizo Plain, San Luis Obispo County (Mus. Vert. Zool.), and to Fresno (Yarrow, U. S. Nat. Mus. Bull., **24**, 1882, pp. 14, 18). Easternmost stations are: Independence, Inyo County (Mus. Vert. Zool.), Pasadena, Los Angeles County (Mus. Vert. Zool.), and Cabezon and Dos Palmos Spring, 3500 feet altitude, Santa Rosa Mountains, in Riverside County (Atsatt, Univ. Calif. Publ. Zool., **12**, 1913, p. 42). Occurs within the Lower Sonoran life-zone. Inhabits open flat country, living in rodent burrows. (See fig. 11.)

Hypsiglena ochrorhynchus Cope

Spotted Night Snake

Original Description.—*Hypsiglena ochrorhynchus* Cope, Proc. Acad. Nat. Sci. Phila., 1860, pp. 246–247.

Type Locality.—Cape San Lucas, [Lower] California.

Common Names.—Rock Snake, Xantus's Snake.

Range.—The southern portion of the state, chiefly in mountainous districts. The stations of occurrence known to us are as follows: Near Christy, Contra Costa County (Mus. Vert. Zool.); foothills near Los Gatos, Santa Clara County (Van Denburgh, Proc. Calif. Acad. Sci., ser. 3, zool., **4**, 1906, pp. 65–66); Shepherd Cañon, Argus Range, Inyo County (Stejneger, N. Amer. Fauna, **7**, 1893, p. 204); near Los Angeles (Rüthling, Copeia, no. 15, February 20, 1915); Hesperia (Van Denburgh, Occ. Papers Calif. Acad. Sci., **5**, 1897, p. 180) and Santa Ana Cañon, 5500 feet altitude (Grinnell, Univ. Calif. Publ. Zool., **5**, 1908, p. 165), in San Bernardino County; Strawberry Valley, 5000 feet altitude, and San Jacinto, in Riverside County (Van Denburgh, *loc. cit.*); San Diego (Van Denburgh, *loc. cit.*), Witch Creek (Cope, Ann. Rep. U. S. Nat. Mus., 1898 [1900], p. 954), and Cuyamaca Mountains (Van Denburgh, *loc. cit.*), in San Diego County. Occurs within the Lower and Upper Sonoran life-zones. Inhabits rocky situations. (See fig. 11.)

Salvadora hexalepis (Cope)

Patch-nosed Snake

Original Description.—*Phimothyra hexalepis* Cope, Proc. Acad. Nat. Sci. Phila., 1866 [1867], p. 304.

Type Locality.—Fort Whipple, Arizona.

Synonyms.—*Salvadora grahamiae hexalepis; Zamenis grahami; Salvadora grahamiae.*

Common Names.—Banded Flat-nosed Snake; Graham's Flat-nosed Snake.

Range.—The southern portion of the state, chiefly in arid situations. Has been taken north to Amargosa Borax Works and Maturango Spring, Argus Range, in Inyo County (Stejneger, N. Amer. Fauna, **7**, 1893, p. 206); west to Arroyo Seco, near Pasadena, Los Angeles County (Grinnell and Grinnell, Throop Inst. Bull., **35**, 1907, p. 42), to Riverside (McLain, Crit. Notes Coll. Reptiles Western U. S., 1899, p. 11) and to San Diego (Cope, Ann. Rep. U. S. Nat. Mus., 1898 [1900], p. 820). Occupies the Lower and Upper Sonoran life-zones. Inhabits hillsides with sparse covering of bushes. (See fig. 11.)

Coluber constrictor vetustus (Baird and Girard)

Western Yellow-bellied Racer

Original Description.—*Bascanion vetustus* Baird and Girard, Cat. N. A. Reptiles in Smiths. Inst., pt. 1, 1853, p. 97.

Type Locality.—San Jose, Santa Clara County, California (so restricted by Van Denburgh, Occ. Papers Calif. Acad. Sci., **5**, 1897, p. 183).

Synonyms.—*Bascanion constrictor flaviventris; Bascanion constrictor vetustum; Zamenis constrictor flaviventris; Bascanion constrictor; Zamenis constrictor;* [?] *Bascanium flagelliforme testaceum*, part.

Common Names.—Blue Racer; California Black Snake; Black Chaser; Yellow Coachwhip Snake, part; Yellow-bellied Black Snake; Green Racer.

Range.—Throughout nearly all of the state, except on the southeastern deserts. Occurs south, east of the Sierra Nevada, at least to Honey Lake, Lassen County (Yarrow and Henshaw, Ann. Rep. U. S. Engineers, 1878, p. 1636); in central California, east to Yosemite Valley, Mariposa County (Van Denburgh, Occ. Papers Calif. Acad.

Sci., **5**, 1897, p. 186), and to Kernville, Kern County (Yarrow, U. S. Nat. Mus. Bull., **24**, 1882, pp. 16, 110); in southern California, east to Fort Tejon, Kern County (Yarrow, *loc. cit.*), to San Bernardino (Van Denburgh, *loc. cit.*, p. 185), and south to Agua Caliente, 3400 feet altitude, in San Diego County (Van Denburgh, *loc. cit.*). Occupies the Lower and Upper Sonoran and Transition life-zones. Inhabits grasslands and wet meadows. (See fig. 13.)

Coluber flagellum frenatus (Stejneger)

Red Racer

Original Description.—*Bascanion flagellum frenatum* Stejneger, N. Amer. Fauna, **7**, May 31, 1893, pp. 208–209.

Type Locality.—Mountain Spring, edge of Colorado Desert, eastern San Diego County, California.

Synonyms.—*Zamensis flagellum flagellum; Zamenis flagellum; Zamenis flagelliformis frenatus; Bascanion flagellum frenatum; Bascanium flagelliforme; Bascanium flagelliforme testaceum,* part; *Bascanium testaceum;* [?] *Bascanium flagelliforme piceum; Herpetodryas flavigularis; Drymobius testaceus.*

Common Names.—Western Whip Snake; Yellow Coach-whip Snake, part; [?] Arizona Coach-whip Snake; Coppery Whip Snake.

Range.—Throughout the desert and coast districts of the southern half of the state, including also the southern San Joaquin Valley. Has been taken northwest to Yosemite Valley, Mariposa County (Van Denburgh, Proc. Calif. Acad. Sci., ser. 2, **5**, 1895, p. 148, footnote), to Fresno (Yarrow, U. S. Nat. Mus. Bull., **24**, 1882, pp. 17, 112), and to Carrizo Plain, San Luis Obispo County (Mus. Vert. Zool.); east of the Sierras, north to Deep Spring Valley, Inyo County (Stejneger, N. Amer. Fauna, **7**, 1893, p. 209). Occurs chiefly within the Lower Sonoran life-zone, extending rarely into Upper Sonoran and doubtfully into Transition. Inhabits open washes, plains, and hillslopes. (See fig. 13.)

Coluber lateralis (Hallowell)

California Striped Racer

Original Description.—*Leptophis lateralis* Hallowell, Proc. Acad. Nat. Sci. Phila., **6**, 1853, p. 237.

Type Locality.—California.

Synonyms.—*Zamenis lateralis; Bascanion laterale; Bascanium taeniatum laterale; Bascanion taeniatus*, part; *Drymobius lateralis.*

Common Names.—Striped Racer, part; Hallowell's Coach-whip Snake; Banded Racer; Few-striped Whip Snake; Striped-side Whip Snake.

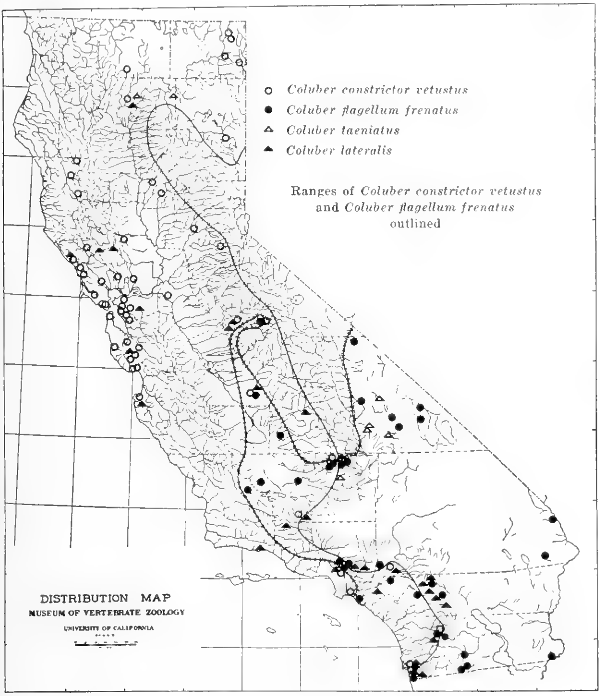

Fig. 13. Distribution of Racers (*Coluber*) in California.

Range.—Southern and west-central portions of the state, chiefly west of the desert divides. Has been taken north to 7 miles west of Cazadero, in Sonoma County (Mus. Vert. Zool.), to Mount Saint Helena, in Lake County (Van Denburgh, Occ. Papers Calif. Acad. Sci., **5**, 1897, p. 190), and to Baird, Shasta County (Cope, Ann. Rep.

U. S. Nat. Mus., 1898 [1900], p. 808); northeast to 5 miles northeast of Coulterville, 3200 feet altitude, in Mariposa County (Mus. Vert. Zool.); east to Fay Creek near Weldon (Mus. Vert. Zool.) and Fort Tejon (Yarrow and Henshaw, Ann. Rep. U. S. Engineers, 1878, p. 1637), in Kern County; to Sierra Madre, 2000 feet altitude, Los Angeles County (Mus. Vert. Zool.); to Cabezon, Strawberry Valley, 6000 feet altitude, and Kenworthy, 4500 feet altitude, in Riverside County (Atsatt, Univ. Calif. Publ. Zool., **12**, 1913, p. 43); and to Dulzura, San Diego County (Mus. Vert. Zool.). Occupies chiefly the Upper Sonoran life-zone, but extends locally into Lower Sonoran and Transition. Inhabits, as a rule, chaparral. (See fig. 13.)

Coluber taeniatus (Hallowell)

Nevada Striped Racer

Original Description.—*Leptophis taeniata* Hallowell, Proc. Acad. Nat. Sci. Phila., **6**, 1852, p. 181.

Type Locality.—New Mexico.

Synonyms.—*Zamenis taeniatus; Masticophis taeniatus; Bascanion taeniatum; Drymobius taeniatus.*

Common Names.—Many-striped Whip Snake; Striped Racer, part; Pacific Coach-whip Snake; Striped Whip Snake.

Range.—Chiefly east of the Sierran divides and north of the Mohave desert. Recorded west at the north to Baird and Canoe Creek, in Shasta County (Stejneger, N. Amer. Fauna, **7**, 1893, p. 210), and southeast through the Inyo region to Maturango Spring, Argus Range, Inyo County (Stejneger, *loc. cit.*). Southernmost station, Walker Basin, Kern County (Yarrow and Henshaw, Ann. Rep. U. S. Engineers, 1878, p. 1637). Occurs chiefly within the Upper Sonoran life-zone. Inhabits sagebrush. (See fig. 13.)

Arizona elegans Kennicott

Faded Snake

Original Description.—*Arizona elegans* Kennicott, *in* Baird, U. S. Mex. Bound. Survey, **2**, 1859, pt. 2, Reptiles, pp. 18–19, pl. 13.

Type Locality.—Rio Grande.

Synonyms.—*Rhinechis elegans; Coluber arizonae.*

Common Name.—Smooth-scaled Coluber.

Range.—The extreme southern portion of the state. All definite stations of occurrence known to us are as follows: Fresno (U. S. Nat. Mus.); Alhambra, Los Angeles County (U. S. Nat. Mus.); near Ontario, San Bernardino County (Van Denburgh, Occ. Papers Calif. Acad. Sci., **5**, 1897, p. 194); Riverside (Van Denburgh, Proc. Calif. Acad. Sci., ser. 4, **3**, 1912, p. 150); San Jacinto, Riverside County (Van Denburgh, 1897, *loc. cit.*); Warner's Ranch (Boulenger, Cat. Snakes Brit. Mus., **2**, 1894, p. 66), between Carlsbad and Oceanside (Van Denburgh, 1897, *loc. cit.*), Vallecito (Mus. Vert. Zool.), and Pacific Beach (Cope, Ann. Rep. U. S. Nat. Mus., 1898 [1900], p. 865), in San Diego County. Occurs chiefly within the Lower Sonoran life-zone. Inhabits open flat country.

Pituophis catenifer catenifer (Blainville)

Western Gopher Snake

Original Description.—*Coluber catenifer* Blainville, Nouv. Ann. Mus. Hist. Nat., **4**, 1835, pp. [58–59] 290–291, pl. 26, figs. 2, *2a, 2b*.

Type Locality.—California.

Synonyms.—*Pituophis annectens* Baird and Girard, Cat. N. A. Reptiles in Smiths. Inst., pt. 1, 1853, p. 72 (type from San Diego); *Pityophis Heermanni* Hallowell, Proc. Acad. Nat. Sci. Phila., **6**, 1853, p. 236 (type from mines in vicinity of Cosumnes River [in Eldorado or Amador County]); *Pityophis vertebralis; Pityophis sayi bellona,* part; *Pityophis sayi; Pituophis bellona,* part; *Pituophis melanoleucus; Pituophis melanoleucus* var. *catenifer.*

Common Names.—Pacific Bull Snake; Bellona Bull Snake; Western Bull Snake, part; Pacific Pine Snake; Gopher Snake, part; Say's Pine Snake; Yellow Gopher Snake.

Range.—The whole length of the state west of the desert divides, but chiefly east of the coast redwood belt. Also found on Santa Cruz and Santa Catalina islands (Van Denburgh, Proc. Calif. Acad. Sci., ser. 4, **4**, 1914, pp. 133, 136, 138). Occupies Lower and Upper Sonoran and Transition life-zones. Shows no particular restriction as regards habitat, though certainly not aquatic.

Pituophis catenifer deserticola Stejneger

Desert Gopher Snake

Original Description.—*Pituophis catenifer deserticola* Stejneger, N. Amer. Fauna, **7**, May 31, 1893, pp. 206–208.

Type Locality.—Great Basin and southwestern deserts [= east slope of Beaverdam Mountains, southwestern Utah (U. S. Nat. Mus., no. 18070)].

Synonyms.—*Pityophis sayi bellona,* part; *Pityophis catenifer,* part; *Pityophis bellona,* part.

Common Names.—Western Bull Snake, part; Southern Bull Snake; Arizona Bull Snake; Gopher Snake, part.

Range.—East of the desert and Great Basin divides, the whole length of the state. Occupies the Lower and Upper Sonoran life-zones. Inhabits nearly all types of arid environment.

Subfamily Boiginae

Tantilla eiseni Stejneger

California Tantilla

Original Description.—*Tantilla eiseni* Stejneger, Proc. U. S. Nat. Mus., **18**, April 16, 1896, pp. 117–118.

Type Locality.—Fresno, California.

Synonym.—*Tantilla nigriceps.*

Common Names.—Eisen's Black-headed Snake; Black-headed Tantilla.

Range.—The southern portion of the state. Only three record stations to date: Fresno, Fresno County (as above); near Mohave, Kern County (one specimen in Southwest Museum at Los Angeles, *fide* C. L. Camp), and near Los Angeles (Rüthling, Copeia, no. 15, February 20, 1915). Seems to belong to the Lower Sonoran life-zone. (See fig. 12.)

Superfamily VIPEROIDEAE

Family CROTALIDAE

Crotalus oreganus Holbrook

Pacific Rattlesnake

Original Description.—"*Crotalus oreganus* Holbrook, N. Amer. Herpetology, 1st ed., **4**, 1840, p. 115, pl. 29 [= 24]" (see Gill, Science, ser. 2, **17**, 1903, pp. 910–912).

Type Locality.—Columbia River.

Synonyms.—*Crotalus lucifer* Baird and Girard, Proc. Acad. Nat. Sci. Phila., **6**, 1852, p. 177 (types from Oregon and California);

Crotalus confluentus; Crotalus lecontei, part; [?] *Crotalus ruber,* part; *Crotalus adamanteus* var. *lucifer; Crotalus oregonus* var. *lucifer; Crotalus confluentus lucifer; Caudisona lucifer; Crotalus Hallowelli* Cooper, Amer. Nat., **3**, 1870, p. 187 (range on southern coast slope of

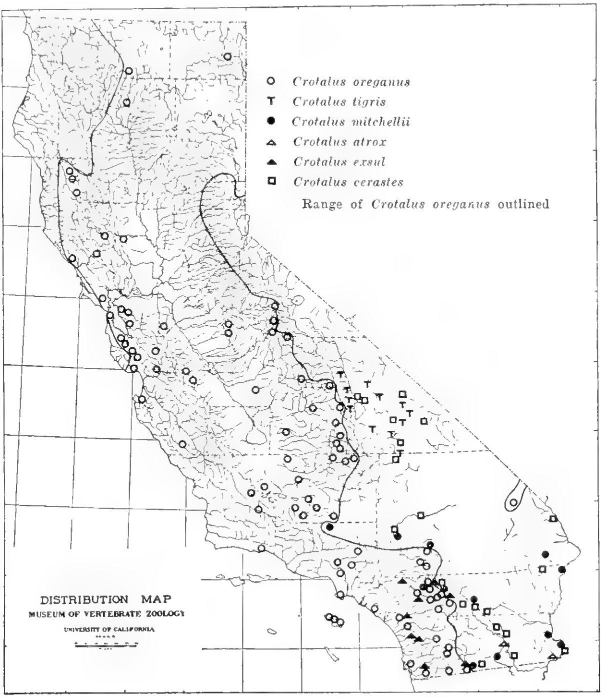

Fig. 14. Distribution of Rattlesnakes (*Crotalus*) in California.

California north to 140 miles north of 30° 30′—"nom. prov."); [?] *Crotalus adamanteus atrox,* part.

Common Names.—Black Rattlesnake; California Rattlesnake; Arizona Diamond Rattlesnake, part; Confluent Rattlesnake; Oregon Rattlesnake; Missouri Rattlesnake; Hallowell's Rattlesnake; Southern Rattlesnake.

Range.—Throughout the state chiefly west and north of the Colorado and Mohave deserts. Extends to an altitude of 8600 feet on the central Sierra Nevada. Has been found on the southeast to Charlotte Creek, 8500 feet altitude, Fresno County (Mus. Vert. Zool.); to Walker Pass (Mus. Vert. Zool.) and Mohave (Meek, Field Columb. Mus., zool. ser., **7**, 1905 [1906], p. 17), in Kern County; to Pine Flats, 5500 feet altitude, San Gabriel Mountains, Los Angeles County (Grinnell and Grinnell, Throop Inst. Bull., **35**, 1907, p. 53); to Doble, 7000 feet altitude, San Bernardino Mountains, San Bernardino County (Grinnell, Univ. Calif. Publ. Zool., **5**, 1908, p. 53); to Banning, Tahquitz Valley, 8000 feet altitude, and Santa Rosa Peak, in Riverside County (Atsatt, Univ. Calif. Publ. Zool., **12**, 1913, p. 45); and to summit of Coast Range, near Mexican boundary, in San Diego County (Cope, Ann. Rep. U. S. Nat. Mus., 1898 [1900], p. 1179). Also found on the Providence Mountains, eastern San Bernardino County (U. S. Nat. Mus.), and on Santa Catalina Island (Yarrow, U. S. Nat. Mus. Bull., **24**, 1882, p. 76). Occupies all life-zones from Lower Sonoran to Canadian. Inhabits almost all types of environment, though apparently commonest on chaparral slopes and in open country where ground-squirrel burrows abound. (See fig. 14.)

Crotalus atrox Baird and Girard

Texas Rattlesnake

Original Description.—*Crotalus atrox* Baird and Girard, Cat. N. A. Reptiles in Smiths. Inst., pt. 1, 1853, pp. 5–6.

Type Locality.—Indianola or San Pedro, Texas.

Synonyms.—*Crotalus adamanteus atrox*, part; *Crotalus lecontei*, part.

Common Names.—Western Diamond Rattlesnake, part; Fierce Rattlesnake; Arizona Diamond Rattlesnake, part.

Range.—Colorado Desert near Mexican boundary. Recorded from Fort Yuma (Yarrow, U. S. Nat. Mus. Bull., **24**, 1882, pp. 12, 75) and Laguna Station, New River (Cope, Ann. Rep. U. S. Nat. Mus., 1898 [1900], p. 1167); both stations in Imperial County. Life-zone, Lower Sonoran. (See fig. 14.)

Crotalus exsul Garman

Red Rattlesnake

Original Description.—*Crotalus exsul* Garman, Mem. Mus. Comp. Zool., **8**, no. 3, June, 1883, pp. 114–115, 174. [Dr. Thomas Barbour has examined Garman's type and finds it to belong to the species which has currently borne the name *ruber.*]

Type Locality.—Cedros Island, Lower California.

Synonyms.—*Crotalus atrox,* part; *Crotalus adamanteus ruber* Cope, Proc. U. S. Nat. Mus., **14**, 1891, pp. 690–691 (type locality unknown); *Crotalus atrox ruber; Crotalus ruber.*

Common Names.—Red Diamond Rattlesnake; Western Diamond Rattlesnake, part.

Range.—Extreme southwestern corner of the state. Occurs north to Reche Cañon (Camp, MS) and Cabezon (Atsatt, Univ. Calif. Publ. Zool., **12**, 1913, p. 44), in Riverside County; east to Dos Palmos Spring, 3500 feet altitude, Santa Rosa Mountains, Riverside County (Atsatt, *loc. cit.*), and to Mountain Spring, in San Diego County (Cope, Ann. Rep. U. S. Nat. Mus., 1898 [1900], p. 1169); west to Deluz (Van Denburgh, Occ. Papers Calif. Acad. Sci., **5**, 1897, p. 228), to Twin Oaks (Stejneger, Ann. Rep. U. S. Nat. Mus., 1893, p. 440), and to El Nido P. O. (Cope, *loc. cit.*), in San Diego County. Occupies the Upper Sonoran life-zone. Inhabits chiefly chaparral-covered and rocky hillslopes. (See fig. 14.)

Crotalus tigris Kennicott

Tiger Rattlesnake

Original Description.—*Crotalus tigris* Kennicott, U. S. Mex. Bound. Surv., **2**, 1859, pt. 2, Reptiles, p. 14, pl. 4.

Type Locality.—Sierra Verde and Pozo Verde [= Sierra del Pozo Verde, Arizona: Stejneger, N. Amer. Fauna, **7**, 1893, p. 214].

Range.—South-central portion of the state east of the Sierra Nevada, chiefly in desert ranges of Inyo County. Recorded northwest to Beveridge Cañon, 8000 feet altitude, Inyo Mountains (Meek, Field Columb. Mus., zool. ser., **7**, 1905 [1906], p. 16); west to Independence Creek and Coso Valley, and south to Slate Range, 3100 feet altitude (Stejneger, *loc. cit.*). Life-zone, chiefly Upper Sonoran. Inhabits rocky situations. (See fig. 14.)

Crotalus mitchellii (Cope)

Pallid Rattlesnake

Original Description.—*Caudisona mitchellii* Cope, Proc. Acad. Nat. Sci. Phila., 1861, pp. 293–294.

Type Locality.—Cape San Lucas, Lower California.

Synonyms.—*Crotalus pyrrhus;* [?] *Crotalus lecontei,* part.

Common Names.—Bleached Rattlesnake; White Rattlesnake.

Range.—The Colorado and Mohave deserts. Has been taken northwest to Fairmont, northern Los Angeles County (Grinnell and Grinnell, Throop Inst. Bull., **35**, 1907, pp. 59–60); northeast to 14 miles northeast of Blythe Junction, San Bernardino County (Camp, Univ. Calif. Publ. Zool., **12**, 1916, pp. 533–534); west to 5 miles southwest of Banning, in Riverside County (Mus. Vert. Zool.), to Asbestos Spring, Santa Rosa Mountains, Riverside County (Atsatt, Univ. Calif. Publ. Zool., **12**, 1913, p. 44), and to Mountain Spring, San Diego County (Van Denburgh, Proc. Calif. Acad. Sci., ser. 2, **4**, 1894, pp. 450–455). Occupies the Lower Sonoran life-zone, extending locally into Upper Sonoran. Inhabits nearly all types of arid environment. (See fig. 14.)

Crotalus cerastes Hallowell

Sidewinder

Original Description.—*Crotalus cerastes* Hallowell, Proc. Acad. Nat. Sci. Phila., **7**, 1854, pp. 95–96.

Type Locality.—Borders of the Mohave River and in the desert of the Mohave.

Common Name.—Horned Rattlesnake.

Range.—Colorado and Mohave deserts; also north into the Inyo region. Northernmost stations are: Mesquite Valley (Meek, Field Columb. Mus., zool. ser., **7**, 1905 [1906], p. 18) and Lone Pine (Stejneger, N. Amer. Fauna, **7**, 1893, p. 218), in Inyo County; westernmost stations are: Oro Grande, in San Bernardino County (Meek, *loc. cit.*), Torres [Toro], west of Mecca, in Riverside County (Mus. Vert. Zool.), and Coyote Wells, in Imperial County (Cope, Ann. Rep. U. S. Nat. Mus., 1898 [1900], p. 1199). Occupies the Lower Sonoran life-zone. Restricted to sand-dune areas and level tracts of loose sandy soil. (See fig. 14.)

Order TESTUDINATA

Suborder ATHECAE

Family DERMOCHELIDAE

Dermochelys schlegelii (Garman)

Pacific Leatherback Turtle

Original Description.—*Sphargis schlegelii* Garman, U. S. Nat. Mus. Bull., **25**, 1884, pp. 294–295 (see also p. 303).

Type Locality.—Tropical Pacific and Indian oceans.

Range.—Ocean off southern coast. Three known instances of capture: Santa Barbara (two specimens), and off Point Loma, San Diego County (one specimen) (Van Denburgh, Proc. Calif. Acad. Sci., ser. 3, zool., **4**, 1905, pp. 51–60, pls. 9–11).

Suborder LAMINIFERA

Family TESTUDINIDAE

Subfamily Emydinae

Clemmys marmorata (Baird and Girard)

Pacific Mud Turtle

Original Description.—*Emys marmorata* Baird and Girard, Proc. Acad. Nat. Sci. Phila., **6**, 1852, p. 177.

Type Locality.—Puget Sound.

Synonyms.—*Emys nigra* Hallowell, Proc. Acad. Nat. Sci. Phila., **7**, 1854, pp. 91–92 (type from "Posa Creek, Lower California" [= Poso Creek, Kern County?]); *Actinemys marmorata; Clemmys Wosnessenskyi* Strauch, Mem. Acad. Imper. Sci. St. Petersb., ser. 7, **5**, no. 7, 1862, pp. 114–117, pl. opp. p. 196 (type from Rio Sacramento, California); *Chelopus marmoratus.*

Common Names.—Western Pond Turtle; Pacific Terrapin; California Terrapin; California Mud Turtle; Western Terrapin; Water Turtle.

Range.—Most of the streams on the Pacific watershed, the whole length of the state. Has been reported east to Pit River [in Shasta County?] (Townsend, Proc. U. S. Nat. Mus., **10**, 1887, p. 237); to 6 miles east of Coulterville, 2800 feet altitude, in Mariposa County (Mus. Vert. Zool.); to South Fork of Kern River, 25 miles above Kernville, in Kern County (Stejneger, N. Amer. Fauna, **7**, 1893, p. 162); and to Mohave River, in San Bernardino County (Cooper, Amer. Nat., **3**, 1870, p. 189); and south to San Diego, San Diego County (Yarrow, U. S. Nat. Mus. Bull., **24**, 1882, pp. 7, 36).

Subfamily Testudininae

Testudo agassizii (Cooper)

Desert Tortoise

Original Description.—*Xerobates agassizii* Cooper, Proc. Calif. Acad. Sci., **2**, 1863, pp. 120–121.

Type Locality.—Mountains of California near Fort Mohave [= "Salado Valley," on Mohave Desert: True, Proc. U. S. Nat. Mus., **4**, 1881 (1882), p. 447].

Synonyms.—*Gopherus agassizii; Xerobates berlandieri.*

Common Names.—Agassiz's Gopher; Western Gopher; Agassiz's Tortoise; Agassiz's Land Tortoise.

Range.—Chiefly the Mohave Desert. Reported north as far as Crater Summit (Van Denburgh, Occ. Papers Calif. Acad. Sci., **5**, 1897, p. 37) and Leach Point Valley (Stejneger, N. Amer. Fauna, **7**, 1893, p. 162), in northern San Bernardino County; west to one-half mile east of Mohave, Kern County, and to 3 miles south of Palmdale, Los Angeles County (Camp, Univ. Calif. Publ. Zool., **12**, 1916, p. 513); south to Cottonwood Mountains, Riverside County (Camp, *loc. cit.*), and, possibly, as far as Fort Yuma (True, *loc. cit.*), Imperial County. Restricted to the Lower Sonoran life-zone. Inhabits, as a rule, flat gravelly or sandy tracts, but found also on rocky hills. (See fig. 9.)

Family KINOSTERNIDAE

Kinosternon sonoriense LeConte

Arizona Mud Turtle

Original Description.—*Kinosternum sonoriense* LeConte, Proc. Acad. Nat. Sci. Phila., **7**, 1854, p. 184.

Type Locality.—Tucson, Sonora [= Arizona].

Synonyms.—*Cinosternum flavescens; Platythyra flavescens.*

Common Name.—Yellow Mud Turtle.

Range.—Lower Colorado River. Two definite stations of occurrence: California side of the Colorado River opposite Yuma (Van Denburgh, Proc. Calif. Acad. Sci., ser. 4, **3**, 1913, p. 396 [see also Cooper, *in* Cronise, Nat. Wealth Calif., 1868, p. 481]); and Palo Verde (Mus. Vert. Zool.).

Transmitted November 21, 1916.

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A STUDY OF THE RACES OF THE WHITE-FRONTED GOOSE (*ANSER ALBIFRONS*) OCCURRING IN CALIFORNIA

BY

H. S. SWARTH AND HAROLD C. BRYANT

UNIVERSITY OF CALIFORNIA PRESS
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H. S. SWARTH AND HAROLD C. BRYANT

(Contribution from the Museum of Vertebrate Zoology of the University of California)

It seems almost incredible that the presence of a bird as conspicuous as a goose should have remained unknown to science until this late date in a state where ornithology has been studied as intensively as in California. But recent information proves this to have been the case. The fact is now established that two well-defined subspecies of *Anser albifrons* occur in California during the winter months, instead of the single race heretofore recognized.

For the material employed in demonstrating the differences between the two forms the authors are indebted primarily to Judge F. W. Henshaw, of the Supreme Court of California, and also to Mr. George Neale, in charge of the Sacramento office of the California Fish and Game Commission. It was through the latter that we received our first intimation of the existence within this state of a gray goose different from the common species. Judge Henshaw secured and donated to the Museum of Vertebrate Zoology a series of fourteen specimens, sufficient in number for the prosecution of a detailed study, and he also supplied valuable written notes upon the habits of these two races of geese as observed in their winter home. Mr. Neale donated two specimens, as described beyond, and also gave us written notes regarding the habits and appearance of the birds in life.

We are under indebtedness of another sort to Dr. Barton W. Evermann, director of the California Academy of Sciences, who permitted examination of the extensive series of white-fronted geese in the collection of that institution.

In the spring of 1916 a conversation took place between the junior author of this paper and Mr. George Neale, in the course of which the latter described what he called a "tule goose" or "timber goose," distinguished from the common white-fronted goose by its much greater size, its call notes, and certain details in its habits. In furtherance of our efforts to ascertain the specific identity of this large goose we obtained during the ensuing winter, from the two donors to whom acknowledgments are made above, specimens as listed below, all taken in the vicinity of Butte Creek, near West Butte, Sutter County, California.

The numerals used in the following pages for reference to specimens are the collection numbers of the Museum of Vertebrate Zoology. All measurements are in millimeters. Color terms are from Ridgway, 1912.

From Judge Henshaw: Nine tule geese, five adult males, three adult females, and one immature female (nos. 27175–27177, 27572, 27573, 27575–27578); five white-fronted geese (nos. 27574, 27579–27582).

From Mr. Neale: Two tule geese, one entire specimen, an adult male (no. 27134), and one specimen consisting of the head and neck of an adult bird, preserved in alcohol (no. 27583).

There is in addition in the Museum collection, a series of thirty-six skins of the white-fronted goose, from the vicinity of Los Baños, Merced County, California. Examination was also made of the series of forty-three specimens of the latter species, from the same locality, in the collection of the California Academy of Sciences.

The first specimen received of the so-called tule goose was a male. The great size of this individual was at first attributed to age, and it was suggested that very old ganders of our common species might sometimes attain exceptional dimensions, much greater than the mode. But the acquisition of additional specimens refuted this conjecture, for females were later secured which in spite of a notable difference in their ages (one of the specimens being immature) were all of approximately the same size, and much larger than the common form of white-fronted goose.

Except for the immature plumage, which is worn for at least the first year, the external appearance of these birds yields no reliable clue to their age. There is a general belief, however, that the black blotching of the lower parts increases in extent with the passage of years; and the individuals occasionally encountered in which the lower breast and abdomen are uniformly black are thought to be of great age. If this idea is reasonable, and it appears to be so, the big birds in question cannot be regarded as being of exceptional age. None has the belly unusually heavily blotched, while on the other hand several of the smaller sized birds are almost entirely black below.

Sex and age having been thus excluded as causes of the observed differences, it became necessary to make a careful comparison of the two series of specimens, the large tule goose and the small white-fronted goose, in order to find a more satisfactory solution of the question. Fortunately, enough examples of both were available to make this practicable.

The difference in size between the two subspecies was equally noticeable whether the comparisons were made before skinning the specimens or in tabulated measurements. This was at once suggestive of a like contrast within the *Branta canadensis* group. The large tule goose may be compared with the Canada goose, which it closely approximates in bulk. The smaller white-fronted goose is comparable to the Hutchins goose in size, while, to complete the analogy, the Asiatic species, *Anser erythropus*, may be paralleled with the tiny cackling goose. A similar variation is to be found in the North American snow geese (*Chen*), there being in this genus three species comparable in size.

A color distinction that is at once apparent between the two series of *Anser* is that the larger birds are of a browner tint, and the smaller ones more gray. This is especially noticeable on the heads and necks. In some individuals of the larger race the head is extremely dark brown, almost black. In the distinctive markings, the white face patch and the black blotches on the belly, there appears to be no difference between the two.

In one of his communications (see below) Judge Henshaw called attention to the fact that the tule goose has a yellow eye-ring, a feature that is not present in the white-fronted goose. This important character is not apparent in a dried skin, and it had been overlooked in the first few specimens that came in, but its presence was verified in all but one of the large geese subsequently received. This marking is similar to that ascribed to *Anser erythropus*, the edge of the eyelid being naked skin, and forming a bright yellow ring about the eye.

It was conspicuously present in both sexes, and even in the single immature female; in only one specimen (no. 27575) was it absent. In the common white-fronted goose the eyelid is dark brown.

Another character that may be noted is the number of tail feathers. Of the six males of the larger race at hand, four have eighteen tail feathers each, and the two which have a lesser number appear to be molting or to have had tail feathers shot away. The four females have each sixteen remiges. Of the series of the smaller race, male and female alike have sixteen tail feathers. Of twenty specimens examined none has more.

In the two lots of birds examined, we thus find differences of size, color of plumage, number of tail feathers, and in the character of the eye-ring. There seems to be no question but that the series are representative of two distinct subspecies at least. In fact, to anyone handling the birds in the flesh, the differences between the two are obvious beyond dispute. Granting, then, the existence of two races, the question arises as to the proper names to be applied to them.

The American white-fronted goose has long been known as *Anser albifrons gambeli* Hartlaub. It would seem at first thought that the more common North American species (and evidently one of these two species is much more common than the other, in California at least) should be the one to bear this name, but careful consideration of the question makes it seem doubtful that this is the correct interpretation of the facts.

Hartlaub's description (1852, p. 7) of *Anser albifrons gambeli* reads as follows:

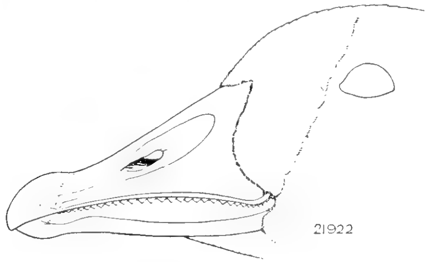
Anser Gambelli, Nob.—(Notice provisoire.)—*Synon.* Anser albifrons Americ. septentr.

Nous avons examiné trois exemplaires de cette espèce d'Oie, dont deux provenaient du Texas et l'un du sud de l'Amérique du nord. Ce dernier est *presque* adulte; les deux du Texas sont des jeunes. L'énorme grosseur et la forme différente du bec nous force de séparer cette espèce de notre *albifrons*. Voici les dimensions comparatives:

	A. Gambelli	A. albifrons
Longit. rostri a fr.	2″ 4′ ″	1″ 6′ ″
A rict.	2″ 4′ ″ ½	1″ 8′ ″
Altitud. rostri later.	1″ 2′ ″	10′ ″ ½
Circumferent. rostri ad bas.	3″ 6′ ″	2″ 11′ ″
Longit. tars.	2″ 8′ ″ ½	2″ 2′ ″
Dig. med.	2″ 10′ ″	2″ 6′ ″

Le congrès des ornithologistes, à Berlin, en 1851, a approuvé la séparation spécifique de cette Oie américaine.

As regards most of the measurements given in the above description, it is apparently impossible to ascertain the exact manner in which they were taken. Hence it is difficult to use them in making comparisons. One of Hartlaub's measurements, ("Longit. rostri a



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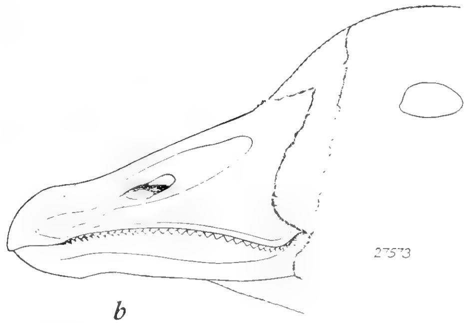

b

Fig. A. *Anser albifrons albifrons*, adult male, no. 21922, Los Baños, Merced County, California; natural size.

Fig. B. *Anser albifrons gambeli*, adult male, no. 27573, West Butte, Sutter County, California; natural size.

fr.") may safely be assumed as corresponding to length of culmen as we have measured it. This measurement, as given for his *A. Gambelli*, translated into millimeters (58 mm.), is within the range of variation of our larger goose. It can not be applied to the bill of the smaller variety.

Howsoever they were taken, Hartlaub's measurements show about the same proportional differences between the two races he had in hand, as there are in our two sets of birds. His new species was evidently a very large bird, and one, at least, of the measurements he gives of it can be applied to the larger of our two forms. It seems safe to say, therefore, that the name *Anser albifrons gambeli* should be used for our large tule goose.

The question then arises as to the status of our small white-fronted goose, which is evidently by far the more common of the two in California. European writers have been reluctant to recognize an American race of *Anser albifrons.* Salvadori (1895, p. 97) describes *gambeli* as "scarcely different from *A. albifrons;* on the average it is larger and has a bigger bill." Alphéraky (1905, p. 42) refuses to recognize *gambeli* at all, though conceding that occasional specimens from North America attain a greater size than any European birds. Of descriptions and measurements as given in most of the American literature on the subject, it may be said that the diagnoses are not convincing as proofs of the subspecific identity of *Anser a. gambeli,* though there is throughout recurrent mention of occasional unusually large sized birds. (In this connection see Coues, 1874, p. 547.) It seems likely that confusion has arisen through failure to discriminate between two perfectly distinct races, and that the explanation of the puzzle is as follows: That *gambeli* exists as a distinguishable North American subspecies of large size, as originally described, but that there also exists in North America another form of smaller size, and that the two occur together during the winter months. The smaller bird is, to all appearances, indistinguishable from the European form. In other words, the race of the white-fronted goose which is most common on the Pacific coast of North America is *Anser albifrons albifrons* (Scopoli).

In testing this theory reference should be made to the accompanying tables. The measurements of European *A. albifrons albifrons* are taken from Alphéraky's (1905, p. 46) careful study of the species. The California series of this subspecies used in comparison was collected at Los Baños, Merced County, during the winter of 1911–12. It will be noted that the measurements of this last series fall within the extremes given for the European birds. No European or Asiatic specimens are available for actual comparison, but no differences, save of size, are claimed to exist between these and American birds, and as it is evident that there are no size differences between the series here compared, it seems justifiable to apply to the smaller American race the name of the common European subspecies, *Anser albifrons albifrons.*

The differences existing between the two subspecies may be summarized as follows:

Anser albifrons albifrons

Size small (wing 384–422); bill small (culmen 44–52); tail feathers, sixteen; coloration in general paler, head and neck grayish; naked skin at edge of eyelid, grayish brown.

Anser albifrons gambeli

Size large (wing 420–475); bill large (culmen 53–62); coloration in general darker, neck dark brown, head blackish; tail feathers, male eighteen, female sixteen; naked skin at edge of eyelid, yellow or orange.

In colors of "soft parts," before the birds are skinned, there were no distinguishable differences between the two series in eyes, bill or feet. The eyelids of the two varied as already pointed out. According to Stejneger (1885, p. 146) appreciable changes occur within an hour after death, and as probably none of our specimens came to hand until after a lapse of at least twenty-four hours, the colors as we noted them, particularly of the bill, may be quite different from those of the living bird. There were great changes, however, in these parts after the prepared skins had begun to dry. Some faded and some darkened.

An adult male of *Anser a. gambeli* (no. 27134) was colored as follows: Upper mandible, general ground-color, light buff tinged with purplish along culmen and at the edges; lower mandible, upper edge of rami, purplish, lower edge, yellowish; naked skin between rami, light buff; feet (tarsus, toes and web), ochraceous salmon. The color of eyes in all the specimens was dark brown.

As of general interest it is worth while to record here the fact that all the birds taken in January were molting extensively, over head, neck and body. There was evidently a general freshening of plumage, apparently involving everything but flight feathers to a greater or less extent. Newly appearing black feathers on the lower parts were particularly noticeable.

The present study is based entirely upon specimens collected in winter. Not a single breeding bird is available for comparison, unfortunately, so that we are unable to indicate the summer ranges of the two North American forms.

The following theoretical breeding ranges are suggested by the facts thus far ascertained, though demonstration of the truth of the hypothesis must depend upon future investigation. With *Anser albifrons albifrons* occurring commonly in the western United States during the winter months, it would seem fair to assume that the known summer range of the subspecies, covering northern Europe and Asia, also extends continuously over western Alaska, and for an undetermined distance eastward. Pursuing this hypothesis, and assuming, as we have the right to do, that the two races do not occur together during the breeding season, we may infer that the summer home of the large *A. a. gambeli* is restricted to points farther eastward in Arctic America than the region inhabited by *A. a. albifrons.* This distribution would explain the relative scarcity of the first mentioned upon the Pacific Coast. Study of specimens from the Mississippi Valley and points farther east should go far toward confirming or refuting this theory, for upon the hypothesis advanced, the condition existing there, must be the opposite of that obtaining in California. There should be, namely, an abundance of the larger *Anser a. gambeli,* and a scarcity of the smaller race. In this connection it is of interest to note a comment made by Nelson (1877, p. 136) upon specimens from Illinois: "I have examined a number of specimens, which by correct comparison were at least *one-fourth* smaller than the average."

The white-fronted goose is known, of course, to breed commonly in Alaska, but there are no Alaskan skins at hand for comparison; nor have we been able to discover published measurements of specimens either from this section or elsewhere in America, in which dimensions of specified individuals are given together with explicit statements of exact place of capture. Consequently the assumption that the breeding bird of western Alaska is identical with the smaller of the two subspecies visiting California in winter, is an unproven hypothesis. It can be said, however, that measurements of eggs from the Yukon region, as given by Nelson (1887, p. 83) agree reasonably well with the dimensions given by Alphéraky (1905, p. 56) for those of the European bird. Eggs of a set in the Museum of Vertebrate Zoology (no. 714) from Cape Vancouver, Alaska, are close to the minimum dimensions given by Alphéraky. It would seem that eggs of the large sized *A. gambeli* should be measurably larger than those of *A. albifrons.*

In considering the possible continuity of range of *Anser a. albifrons* over Asia and Alaska, mention must be made of a goose taken by Stejneger (1885, p. 145) upon Bering Island, which he records as *Anser a. gambeli,* saying that "it matches average North American specimens in every particular.'' The following details of this bird can be used in comparison with our data: Sex, female; total length, 685 mm.; wing, 417; tail feathers, 124; bill, from tip to frontal feathering, 51; tarsus, 78; middle toe with claw, 76; weight, 6¾ pounds (fat); naked eye-ring, dark brownish gray.

It is, of course, uncertain whether these measurements were taken in the same manner as our own, but, disregarding this possibility, it will be seen from the figures given that the total length accords with that noted by us for the smaller American race, which we call *albifrons*, while the others are all intermediate between the two. Stejneger, with his customary painstaking accuracy, carefully records the color of the naked eye-ring, most fortunately so, as it appears to be a valuable character. The fact that it is dark brownish gray in the specimen in question seems, with little doubt, to stamp the bird as *Anser a. albifrons.*

On the whole, while concurring with this author that his Bering Island white-fronted goose agrees with average North American birds in its characteristics, we believe it belongs to the smaller, apparently the more common, of the two American races. Its slightly greater size, as compared with most European *A. albifrons*, is in accord with Alphéraky's finding of an increase in the size of birds from eastern Asia, as compared with European specimens.

All of the examples of tule geese at hand came from a limited region in the Sacramento Valley, in the vicinity of Butte Creek and Butte Slough, in Sutter County. While the bird is apparently of fair abundance in this region in winter, we have little data demonstrating its presence at any other point in the state. In the extensive series of *A. albifrons albifrons* in the collections of the Museum of Vertebrate Zoology and of the California Academy of Sciences, all taken in the vicinity of Los Baños, Merced County, in the San Joaquin Valley, there is not a single example of the larger bird. There is, however, a persistent rumor among market-hunters of the Los Baños district to the effect that a large form of white-fronted goose exists and has been killed there. In a letter received from Mr. George Neale, the statement is made that Mr. A. W. Stuart, of Grand Island, once killed two large gray geese, ''as large as honkers,'' at Maine Prairie, Solano County.

In the Sacramento Valley, market-hunters and the sportsmen of the gun clubs alike affirm the existence of two races of the white-fronted goose, differing in appearance, habits and call notes. It is said that the two kinds flock separately, for the most part; and that the larger race is never seen in such big flocks as is customary with the other, but is most frequently noted singly or in pairs. Also that while the smaller variety is a common frequenter of grain fields and uplands generally, the larger one is pre-eminently a denizen of open water or of ponds and sloughs surrounded by tules and willows. The predilection of the latter species for such localities has given rise to the local names by which it is known, "tule goose" or "timber goose," as contrasted with the upland-frequenting "speckle-belly."

The habits and appearance in life, of the tule goose are described in the following excerpts from a letter written by Judge F. W. Henshaw to Dr. J. Grinnell, director of the Museum of Vertebrate Zoology:

On Monday last, Jan. 22nd, accompanied by my friend Sam Lamme, I went out to secure for you some tule geese on the grounds of the West Butte Country Club in the Sutter Basin. We went by boat into the more unfrequented and inaccessible parts of this lake and there shot for you four tule geese and five American white-fronted geese. Sam Lamme is remarkable even for a professional hunter. His ability to call wild fowls of all kinds is little short of marvelous, and we could easily have killed more of these birds, but we stopped when we had secured the number that you desired. We were out only during the morning, and in that time (accepting Sam's verdict as to their character) we certainly saw over 150 tule geese. Usually they were single birds or in pairs, though at times we would see flocks of eight, ten, twelve, or sixteen. At times also we saw mixed flocks. Sam explained this by saying that the tule geese never joined the smaller white-fronted geese, but that the latter would frequently attach themselves to a pair or to a flock of tule geese and trail on behind. I was myself a witness to the joining of these birds upon several occasions. The tule geese were always in the lead, paying no attention to the other geese which joined them, and in turn the other geese would frequently leave the tule geese after accompanying them for a short time. When the tule geese were by themselves and at a distance it was difficult for me to tell with any certainty whether they were tule geese or the ordinary white-fronted geese, but when the two kinds were together the difference was most plain and showed not alone in size but in the conspicuously longer neck of the tule geese. Also the notes of the tule goose, according to Sam, while similar, are of different quality from those of the white-fronted goose, and while I was unable to detect the difference myself, he frequently verified his own nicer sense of hearing. The difference he described by saying that the notes of the tule goose were coarser and harsher. His nicety of ear I had him demonstrate upon several occasions. He would say upon hearing the call of a bird, "that is a tule goose," or "that is a gray goose," and I would reply, "call him in, Sam, and let's make sure." When he did so, in every instance his judgment proved to be correct. In explanation of this, let me say that he called many of both varieties within range of our guns after we had killed all that you required, so that in many instances I had to base my conclusion upon observation of the birds in the air. Another noticeable fact was that the tule geese, while shy in the sense that they resorted to the more remote parts of the marsh—the white-fronted geese being everywhere by the hundreds—were much more confiding and answered much more readily to Sam's call, coming in directly and without the usual wary circling. Several times, for example, it happened that in a mixed flock the white-fronted geese would turn and leave, while the tule geese would come sailing on to what would have been their destruction.

I mentioned to you over the phone the conspicuous bright orange membrane fully surrounding the eye of the tule goose. It did not appear upon any specimen of the white-fronted goose, and Sam declared that he had never seen it on a white-fronted goose. Sam, I should add, was born in Sutter county, has been for years a market hunter, and is exceptionally endowed with powers of observation and wild fowl mimicry.

Transmitted May 1, 1917.

Measurements in Millimeters (Average, Minimum, and Maximum) of the Races of *Anser albifrons*

	Wing	Tail	Culmen
6 male *Anser albifrons gambeli;* California	447.2 (430.0–475.0)	135.5 (124.0–144.0)	60.1 (57.0–62.0)
10 male *Anser albifrons albifrons;* California	409.6 (384.0–422.0)	121.2 (107.0–135.0)	49.6 (46.5–52.0)
4 female *Anser albifrons gambeli;* California	430.5 (420.0–440.0)	127.2 (110.0–135.0)	55.6 (53.0–58.0)
10 female *Anser albifrons albifrons;* California	394.5 (384.0–404.0)	119.6 (113.0–126.0)	46.0 (44.0–48.0)
Adult *Anser albifrons albifrons;* Old World	375.0–435.0[1]	....	40.0–56.0[1]

	Height of bill	Tarsus	Middle toe without claw
6 male *Anser albifrons gambeli;* California	26.5 (25.0–28.0)	81.9 (80.0–84.0)	79.6 (73.0–84.0)
10 male *Anser albifrons albifrons;* California	23.3 (21.5–26.0)	73.6 (71.0–79.0)	67.1 (61.0–73.0)
4 female *Anser albifrons gambeli;* California	25.7 (25.0–27.0)	79.0 (77.0–83.0)	75.0 (73.0–80.0)
10 female *Anser albifrons albifrons;* California	20.4 (18.0–21.5)	70.1 (64.0–73.0)	63.1 (58.0–68.0)
Adult *Anser albifrons albifrons;* Old World	23.5[1]	51.0–81.0[1]	....

	Total length[2]	Spread wings[2]
6 male *Anser albifrons gambeli;* California	830.5 (810.0–854.0)	1623.6 (1560.0–1670.0)
2 male *Anser albifrons albifrons;* California	733.0 (730.0–736.0)	1476.5 (1471.0–1482.0)
4 female *Anser albifrons gambeli;* California	779.7 (745.0–797.0)	1572.0 (1510.0–1661.0)
3 female *Anser albifrons albifrons;* California	687.6 (685.0–692.0)	1405.3 (1384.0–1437.0)
Adult *Anser albifrons albifrons;* Old World	635.0–760.0[1]	....

Weights (Average, Minimum, and Maximum) of the Races of *Anser albifrons*

6 male *Anser albifrons gambeli;* California	7 lbs. 4 oz. (7 lbs. 1 oz.–7 lbs. 8 oz.)
2 male *Anser albifrons albifrons;* California	5 lbs. 4 oz. (5 lbs.–5 lbs. 6 oz.)
4 female *Anser albifrons gambeli;* California	6 lbs. 5 oz. (5 lbs. 5 oz.–7 lbs.)
3 female *Anser albifrons albifrons;* California	4 lbs. 12 oz. (3 lbs. 14 oz.–5 lbs. 8 oz.)
Adult *Anser albifrons albifrons;* Old World	.... 4 lbs.–6 lbs.[3]

[1] Alphéraky, 1905, p. 46.

[2] Measured prior to skinning.

[3] Extremes of twenty-one specimens; Alphéraky, *loc. cit.*

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PLATE 13

Skins of adult males of *Anser albifrons albifrons* (at left), Mus. Vert. Zool., no. 27581, and *Anser albifrons gambeli* (at right), Mus. Vert. Zool., no. 27134; photographed on same scale.

These specimens are fairly representative of the size differences existing between the two forms. Both were prepared by the same person, and care was exercised that neither should be unduly lengthened or shortened. In each case the dried study skin measures in total length within a few millimeters of the same measurement as taken before the bird was skinned.

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BY

HILDA WOOD GRINNELL

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A SYNOPSIS OF THE BATS OF CALIFORNIA

BY

HILDA WOOD GRINNELL

(Contribution from the Museum of Vertebrate Zoology of the University of California)

CONTENTS

INTRODUCTION

The paper here presented is the result of the writer's endeavor to gather together, and to add to, the facts already known concerning the distribution and habits of the California representatives of one of the most interesting, though least known, groups of mammals, the bats. The records of palaeontology show the great antiquity of the order to which the bat belongs; indeed, the bat had become master of the air long before man walked upright. The first fire the cave man lighted in his rocky refuge revealed to him the "little upside-down bat" clinging to the roof of his cavern, and doubtless he knew more of its habits than we do today. In the course of ages, as man withdrew himself more and more from contact with the wild creatures and became more imaginative, he grew to fear this haunter of caves and dweller in darkness. Shakespeare but voiced the popular sentiment of his day when he classed the bat with toads, snakes, and newts, a fit ingredient for the witches' brew. In reality, however, the bat is a warm-blooded, friendly little creature, as deserving of our good will as the bird whose place he takes at twilight, when he skims the air for those insects which escape the vigilance of the bird by reason of their time of flight.

The number of students of natural history within our state is rapidly increasing and it is hoped that by turning their attention more generally toward our bats, this paper may be the means of extending our knowledge of these animals far beyond the limits of the present summary. The facts gathered together here have been derived from the following sources: All the available published literature; the data attached to specimens; the many volumes of collectors' manuscript field notes on file in the California Museum of Vertebrate Zoology; and the writer's own study of specimens in the Museum and of live bats in the field. As a rule, the source of facts cited on authority is designated. All specimens listed are contained in the Museum of Vertebrate Zoology, except where their location is otherwise indicated.

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For permission to examine the collections under their charge and to make use of data derived from them, the writer is indebted to Dr. Charles H. Gilbert and Professor John O. Snyder of Leland Stanford Junior University; to Dr. Barton W. Evermann and Mr. John Rowley of the California Academy of Sciences; to Professor Charles A. Kofoid of the University of California; to Dr. Leonard Stejneger, Mr. Gerrit S. Miller, Jr., and Mr. Ned Hollister of the United States National Museum; to Mr. Henry W. Henshaw, Mr. E. W. Nelson and Mr. Arthur H. Howell of the United States Bureau of Biological Survey; to Dr. Witmer Stone of the Academy of Natural Sciences of Philadelphia; to Dr. J. A. Allen of the American Museum of Natural History, New York; to Dr. Glover M. Allen of the Museum of Comparative Zoology, Cambridge; and to Mr. Percy A. Taverner, of the Museum of the Canadian Geological Survey, Ottawa. To Dr. Joseph Grinnell of the California Museum of Vertebrate Zoology the writer is indebted not only for permission to make full use of the collections and field notes under his charge, but also for encouragement and frequent help given during the five years in which this paper has been in preparation.

A preliminary manuscript, the first draft of the present paper, was prepared when the writer was a graduate student in the Department of Zoology of the University of California, in 1912–13; during that year much kindly criticism was received from Professor Charles A. Kofoid, head of the department.

To Mr. Charles L. Camp, Mr. Wilson C. Hanna, Miss Grace Swerdfeger, Miss Winifred N. Wear, and Messrs. Eldon, Adrey, and Raleigh Borell, the writer is under obligation for contributions of living specimens of bats.

Mr. Frank Stephens has generously permitted the use of notes gathered during many years of field study of California mammals.

Finally, the author is deeply indebted to the entire staff of the California Museum of Vertebrate Zoology for aid given in many ways. The facilities afforded in this institution for this special study have been indispensable.

Material

The Californian material studied, and upon which this paper is based, consists of some 1500 specimens, from the following sources: 942 specimens from the Museum of Vertebrate Zoology; 218 from the collections of Leland Stanford Junior University; 107 from the United States National Museum; 88 from the collection of the United States Bureau of Biological Survey; 34 from the collection of the

Academy of Natural Sciences, Philadelphia; 20 from the collection of the Department of Zoology of the University of California; 20 from the American Museum of Natural History, New York; 17 from the collection of the California Academy of Sciences, San Francisco; 9 from the Museum of Comparative Zoology, Cambridge; 9 from the collection of the San Diego Society of Natural History; 5 from the collection of Frank Stephens; and 1 specimen from the collection of F. W. Koch.

Many specimens of bats from outside of the State of California have been used in comparison, and these are also from the above-named sources, and from the Museum of the Canadian Geological Survey, Ottawa.

The material examined has consisted chiefly of dry skins with skulls; but it has generally been possible to secure fresh and alcoholic specimens from which to derive the essential supplementary data.

Measurements

Throughout this paper all measurements of total length, tail vertebrae, and foot are as taken in the flesh by the collector, unless otherwise stated. These are likely to be somewhat longer than measurements obtainable from dried skins or from alcoholic specimens. Since averages are useful only for comparison with other averages, detailed measurements of specimens are given wherever possible. In selecting specimens for measurement examples have been chosen which show extremes of variation, as far as contained in the material at hand.

All measurements are stated in millimeters. In the fresh specimen it is customary to measure the total length, and lengths of tail, foot, ear, and tragus. To do this with facility, the bat should first be laid out flat upon its back, when the total length from end of nose to tip of tail, may be taken. When the tail is to be measured one point of a pair of dividers should be set on the rump at the extreme base of the tail and the other point placed at the tip of the straightened tail. The foot should be measured from the tip of the longest claw to the upper edge of the heel. Two methods of measuring the ear are used and as these differ somewhat in results the particular one used should always be specified. One is ''ear from crown,'' and is taken with one point of the dividers set on the skull on the inner (convex) side of the ear and the other at the tip of the ear. The second method, and one which results in a slightly longer measurement, is ''ear from meatus," one point of the dividers being placed in the meatus, the other at the tip of the skin of the ear, as before. The first-named method of measuring the ear is recommended as it seems to admit less chance of error. By either method the measurement is, of course, of more value when taken from the fresh (unskinned) animal.

Modes of Preserving Bats

Two modes of preserving bats as specimens are used by collectors, namely, immersion in an alcohol or formalin solution of sufficient strength to arrest decay and yet not of such concentration as to harden the tissues unduly; and preservation as dry stuffed skins, with the skull cleaned and saved separately. The latter method is that usually employed in preserving other mammals.

Since the color of the fur of bats is of great importance in specific and subspecific determinations, and since the skulls are of prime importance in the matter of general identification, the second method is to be recommended in most cases. A bat skin should be made up in the same way as are the skins of other small mammals, save that no wire should be used in the wings or feet, the tail only being wired. The wing bone should be cut at about the middle of the humerus and the distal portion of that bone, together with all the other wing bones, left in position. The femur should be cut at the middle and its distal portion, together with all bones of the lower leg (tibia) and foot, left in position. In "setting" a bat skin, the wings should be neatly folded along the sides and held so by pins at the sides (but not through the membranes) until dry, the interfemoral membrane should be well spread, the feet turned slightly outward, and the knee joint slightly bent. Observance of these precautions will facilitate the measuring of bone lengths in the dry skin.

Where several specimens of the same species of bat are secured, one or more may be preserved as alcoholics, since the form of the wings and ears are more easily studied in bats preserved in this way.

Senses of Bats

The writer of the present paper has had no opportunity to carry on experiments to determine the relative value of the different sensory adaptions of bats; so there are here quoted the conclusions of Hahn (1908, pp. 135–193) and of Ackert (1914, pp. 301–343).

Eyesight.—Hahn (*loc. cit.*, p. 155) says of the sight of bats:

After extended observations on the subject, I am still unable to form any definite conclusions with regard to the importance of sight to these animals. That they can see light and darkness and moving objects is unquestionable. That the sense of sight is not highly developed is equally certain. The behavior of some of the animals appears to indicate that at times they depend on this sense to a considerable degree, both in securing food and in avoiding objects.

J. Grinnell (1913*a*, pp. 344–345) suggests that the fact that a given species of bat will appear abroad at a certain time almost to the minute each evening shows that these animals can appreciate light intensity within a very narrow range.

It is suggested by Hahn (1908, p. 157) that a bat dipping to drink water from a quiet pool is probably attracted to it by sight, but that the rising of moisture-laden air also helps the animal to locate water.

Hearing.—Low-pitched rumbling noises have no effect upon bats; but to vibrations of high frequency these animals are extremely sensitive (Hahn, *loc. cit.*, p. 155). This is as one would expect to find it, since the hum produced by flying insects is usually high-pitched, and the voices of the bats themselves are very shrill.

Hahn (*loc. cit.*, p. 156) found that as a rule the bats he had under observation paid no attention to worms held near them, as long as the worms remained quiet, but became excited as soon as the worms began to wriggle. As this occurred when the bats were not touched by the worms and when they were out of the range of vision, Hahn infers that the food must have been perceived through the tactile organs, these being stimulated by air currents set in motion by the moving worms. In recording his experiments upon captive bats Hahn (*loc. cit.*, p. 178) says: "Sound associations are formed readily. A sucking noise made by the lips at first alarmed the animals, but they soon learned to associate it with feeding. On hearing it they would look about and snap at any object that could be mistaken for food."

J. Grinnell (1913*a*, pp. 344–345) suggests that bats hunt their insect food by sound. He says: "Even the wing-strokes of a tiny miller must be distinctly audible to the bat which snaps it up so unerringly. And the droning of a June beetle must sound to the bat as penetrating as the roar of a biplane motor does to us."

At least one species of bat, *Antrozous pacificus*, undoubtedly secures a portion of its food upon the earth, since it brings to the roost wingless Jerusalem crickets (*Stenopelmatus*). It seems probable that the bat is attracted to these insects by the noise which they make in crawling about over the ground or, less probably, by air currents due directly to the movements of the insects.

Touch.—For more than a century naturalists have been aware of the dexterity with which blinded insectivorous bats when in flight avoid obstacles, and the suggestion has been repeatedly made that these little animals possess a "sixth sense," which makes them cognizant of the adjacency of objects which they neither see, hear, nor touch. Many experiments have been carried on in the hope of locating this sense. Hahn (1908, p. 191) states that obstacles are perceived chiefly through sense organs located in the internal ear, basing his belief upon the results of experiments in which the external auditory meatus of each bat used was filled with hardened plaster of paris. Ackert (1914, p. 329) regards the experiments of Hahn as inconclusive, believing that a bat so mutilated might not act in a normal manner.

Ackert (*loc. cit.*) himself publishes the results of a search made for sensory structures in the skin of bats. The species used by Ackert were *Myotis lucifugus* and *Myotis subulatus*, species not occurring in California, but members of our most abundantly represented genus. He performed no experiments upon living material, but confined his investigations to the study of prepared sections of the tissues. A review of the literature upon the subject inclined him to the view that condensations (pressures) of the atmosphere set up between an obstacle and a bat stimulate sensory structures in the integument of the bat. These structures Ackert suggests would have to meet the two conditions of distribution over the parts of the bat foremost in flight, and of superficial location, as stimulations from air pressures are doubtless very slight.

Two types of sensory end organs found by Ackert (1914, pp. 330–331) in the skin of bats seem to him to meet the requirements mentioned. The first of these consists of free nerve terminations (end-knobs) found in enormous numbers near the surface of the epidermis. Second, are the superficial nerve rings (and their terminal fibers), which are so situated about the necks of the hair follicles as to be affected by even the slightest movement of the hairs. This investigator states that the area of the integument supplied by superficial nerve rings is insignificant in comparison with the area supplied with nerve end-knobs. Likewise, the number of terminal fibers of the rings is not to be compared with the enormous number of end-knobs in the epidermis. He remarks, finally, that

It is not, of course, to be inferred that all the free end-knobs function alone as pressure perceptors, for, as is well known, the sensory nerves of the human skin mediate at least four different qualities of sensations, namely, pressure, warmth, cold, and pain. But the number of nerve end-knobs in the skin is so great, and the latter in the bat is so sensitive to delicate tactile stimuli, that the number of free nerve terminations in the epidermis functioning as pressure perceptors must necessarily be very large.

I have repeatedly watched captive bats, of several species, when loosed in a many-windowed room, and though they were clearly seeking a means of escape, not one was ever seen to dash against a window pane, as does a bird under like circumstances. These bats were in full possession of the faculties of sight and hearing. To judge from the actions of birds similarly situated, neither faculty could apprise these creatures of the fact that glass is an impenetrable barrier. The only theory which seems adequately to explain the bats' recognition of the invisible barrier, glass, is that condensations (pressures) of the atmosphere set up between the window-pane and the bats stimulate sensory structures in the integument of the bats, as suggested by Ackert, or possibly, in the internal ear, as Hahn considered probable.

According to Barrett–Hamilton (1911, p. 42), we must give Cuvier credit for this theory. He says: "It seems that Cuvier was not far wrong when he wrote that 'it is by means of the pulsations of the wings on the air that the propinquity of solid bodies is perceived, by the manner in which air reacts upon their surface.' "

Smell.—Hahn (1908, p. 154) suggests that since bats catch their food in the air where a flying insect leaves no permanent path and cannot be definitely localized by its odor we must infer that the bat in seeking food does not rely on its sense of smell. But he adds: "It must not be inferred . . . that the sense of smell is lacking, or even rudimentary. All bats have a strong odor, the purpose of which is probably to attract others of their kind. This may be taken as an indication that smell is well developed, for otherwise the odor would be useless." The same author enumerates several instances in which captive bats failed to locate food which could have been found only through the sense of smell.

Taste.—I can find no statements concerning a sense of taste among bats except the very general one by Barrett–Hamilton (1911, p. 28): "In captivity practically all insects are accepted except those which are distasteful to insectivorous animals generally."

Habits of Bats

The habits of our California bats are, unfortunately, but little known. The time and extent of the breeding season, migration and hibernation, the choice of diurnal retreats, and favorite feeding-grounds, the methods of securing and devouring prey, the nature of the food, the economic value of bats—these are only a few of the many points on which data are as yet almost wholly lacking.

The scanty material which the writer has been able to gather regarding the habits of our bats is given in the succeeding pages under the subheading Natural History, at the close of the description of each species. However, certain general topics, such as migration, are separately discussed in the paragraphs immediately following.

Migration.—Recorded observations concerning the migration of bats are few, and in California the study of bat migration has not progressed beyond the observation that some species which are common in fall and winter are not to be seen during the summer months, while others known to occur during the summer are apparently absent during fall and winter.

Among the bats of California are found three species which occur in suitable localities throughout the whole United States and in British Columbia. These are the Silvery-haired Bat (*Lasionycteris noctivagans*), the Hoary Bat (*Nycteris cinereus*), and the Red Bat (*Nycteris borealis*), of which latter species several races occur. These three bats are known to be migratory in at least portions of their ranges, and some of the facts relating to their migration are of general interest.

As Dr. C. Hart Merriam (1887, p. 85) points out, all North American bats, except in those places where their habits have been modified by proximity to man, may be classed either as *cave-dwelling* or as *tree-dwelling*, according to the places in which they spend the day. As a rule, the cave-dwelling species live in large colonies, while the tree-dwelling species live singly or in but small companies. Now it is well known that the temperature in caves is little affected by the condition of the atmosphere outside, while the temperature of holes in trees and recesses in the foliage is about the same as that of the surrounding air. These three migratory bats are here in California foliage-dwellers, exposed as directly as are birds to changes in atmospheric temperature.

Merriam gives no details of the extent or exact northward and southward movements of the silvery-haired or hoary bats in the east, but he records the occurrence of the former species about the lighthouse on Mt. Desert Rock, thirty miles off the coast of Maine, in spring and fall. On this treeless islet bats are at other times unknown.

Seton (1909, p. 1175–1176) states that on the Red River at Winnipeg he has found the silvery-haired bats common from the vernal equinox until about September 21, after which they are neither seen flying, nor found in their accustomed daytime haunts.

The hoary bat breeds only in the boreal zone of North America, but it has never been recorded in this zone in winter. In winter it occurs regularly at least as far south as the southern border of the United States. It has been taken on the Bermudas, showing that it is able to cross a strip of ocean having at its narrowest extent a width of over six hundred miles. It is, however, as suggested by Miller, much more likely that the bats commence their ocean journey at some point much farther to the north, such as Cape Cod, the distance from which to the Bermudas is about seven hundred miles. Of this bat's occurrence in the Bermudas, J. M. Jones (1884, pp. 145–146) says that it "is observed occasionally at dusk during the autumn months hawking about according to its nature in search of insects; but as it is never seen except at that particular season it is clear that it is not a resident, but merely blown across the ocean by those violent northwest gales which also usually bring numbers of birds from the American continent." The latest date at which Seton has recorded hoary bats in Toronto is mid-September. Major Mearns (*in* Howell, 1908, p. 37) records a diurnal flight of hoary bats at Fort Snelling, Minnesota, but no details are given.

In regard to the red bat, Seton (1909, p. 1189) says that in summer, in Manitoba, this bat roosts in trees, it is solitary, and is not known to frequent caves. "In winter it is known to gather in vast numbers in the caves of its more southerly range." Seton gives no authority for the statement that this bat hibernates in caves, and I can find no confirmation of his statement in accounts by other writers. In southern California where the red bat is often found in evergreen trees in winter it has never, so far as I am aware, been found in caves. Writing from the Hudson Highlands of New York, where this bat is very common in summer, Mearns (1898, p. 345) says: "During the latter part of October and the first week of November, I have seen great flights of them during the whole day. In 1876 I noted that all of the individuals shot from any single flock were of the same sex, though another flock might yield all of the opposite sex."

Rhoads (1903, p. 213) writes:

> I have observed this species returning from apparently extensive flights over the ocean on the N[ew] Jersey coast in the early morning before sunrise. On one or two occasions in September single individuals have been observed flying directly toward the shore, so exhausted as to make little progress against a land breeze and alighting on the nearest object as soon as land was reached. It is possible that these had been blown to sea during their migrations along the coast.

It is not generally realized that bats possess powers of flight superior to those of many birds; yet this may be inferred from the fact that a red bat has been known to catch flies in the air while burdened with young that together weighed more than she did.

In August and September, 1890 and 1891, Miller (1897*a*, pp. 541–543) had the opportunity of watching the appearance and disappearance of the above three species of bats at a locality where none could be found during the breeding season. Highland Light, where the observations were made, is situated near the edge of a high place in the series of steep bluffs of glacial deposit which form the outer side of Cape Cod, Massachusetts. The light, which is less than ten miles from the northern extremity of the cape, is separated from the mainland toward the east and northeast by from twenty-five to fifty miles of water. The bluff on which it stands rises abruptly from the beach to a height of one hundred and fifty feet. All three species (the silvery-haired, hoary, and red bats) were found flying for the most part along the face of the bluff, feeding upon the myriads of insects blown there by the prevailing southwest winds. The bats were never seen by Miller in the daytime, although he made diligent search for them. He suggests that they may have found shelter by day in the dense, stunted scrub-oak growth, which crowns the bluff in many places. In 1890 the first bats of the season were seen August 21, and the last September 12. In 1891 the first date recorded is August 25, and the last September 13. Separate records were kept of the different species. The numbers of bats of each species seen in a single evening varied from one to sixteen.

An interesting observation upon the diurnal migration of bats was made by Howell (1908, pp. 35–37) at Washington, D. C., upon the morning of September 28, 1907. The observer first noted bats at 8 A.M. They were all flying with the wind, which was southwest. They did not fly in flocks, but singly, usually but four or five being in sight at one time. The manner of flight was quite unusual, for instead of the erratic zigzag course commonly followed by bats when seeking their food at dusk, the flight of those noted on this occasion was very steady, consisting chiefly of a sailing or drifting motion, with occasional short flappings of the wings. The height above the ground was estimated as varying from one hundred and fifty to four hundred feet. With the aid of a glass three different sizes were noted, but of course it was quite impossible to identify the species. The flight lasted for over an hour and more than one hundred individuals were observed.

Howell suggests the possibility that such diurnal migrations are of regular occurrence, but if that be so, it seems remarkable that they have not been more frequently observed.

Food and Feeding Habits.—There are among bats species which eat fruit, some which eat fish, others which subsist upon blood, and lastly, and by far the most numerous, are those species which eat only insects. The bats native to California are, with one possible exception (see under *Macrotus californicus*, p. 257), strictly insectivorous.

Campbell (1913, p. 1176) states definitely that bats will eat pieces out of hams and bacon left in smoke houses. I know of no other reference to such a habit, outside of nursery rhymes.

Most of our bats catch their prey upon the wing and devour it without alighting. As they eat the insects they bite off and reject the hard parts, which fall to the ground. The soft edible parts are very finely triturated by the sharp teeth, so that it becomes quite difficult to identify the insect remains found in the stomach of a bat. However, one California bat, *Antrozous pacificus*, brings at least the larger of its insect victims to its roosting place, and hangs there while eating. From the insect remains on the floor beneath the roost it is a simple matter to learn the nature of the food (see p. 355).

At least two British bats (Barrett-Hamilton, 1911, p. 172) hold the tail curved beneath them in flight, and one of them has been observed to use the sac thus formed by the interfemoral membrane as a pouch into which it thrusts a struggling insect until it has secured a firm grip upon it. It would be of interest to learn whether any of our species share this habit.

As is the case in other groups of mammals, all our bats become very fat in autumn. Specimens secured in late winter or early spring, on the other hand, are invariably lean. The fat stored up in the fall is absorbed during the period of hibernation or emigration. Those of the non-migratory species which remain on the wing throughout the year seem to rely in good part upon such stored fat to help tide them over the winter months, during which flying insects are available in but scanty numbers.

Breeding Habits.—I have been able to collect data which show the number of young in most of our species of bats, and the approximate time of birth, but the time and extent of the mating season is still unknown. According to Barrett-Hamilton (1911, pp. 31–32), Messrs. Rollinat and Trouessart have established the fact that in France the normal mating time is autumn. Barrett-Hamilton says:

> At that season spermatozoa are found numerously in the uterus of the adult female, and the organs of the male are also functional. Ovulation is, however, postponed until the termination of hibernation, during which period the ovaries are quiescent, but the spermatozoa retain their activity in the uterus until fertilisation takes place, in April. On this point all authorities are agreed, and the facts, subject to correction as to details, may be taken as substantiated. An alternative view, that ovulation and fertilisation may take place in the autumn and winter, with subsequent postponement of the development of the embryo, seems to be unsupported by facts.

Recorded observations of autumnal mating in certain species of the eastern portion of the United States incline one to the belief that nearly related races occurring in California may possess similar habits. Murphy and Nichols (1913, p. 11), writing upon the bats of Long Island, confirm earlier reports of autumnal mating in the eastern red bat (*Nycteris borealis borealis*).

Voice

As is well known to all naturalists, the voices of bats are high and shrill; in other words, the vibrations are of high frequency. Barrett-Hamilton (1911, p. 43) states that a young bat calls for its mother as persistently as any other young animal, and in commenting upon the shrillness of the voices of bats suggests that some of their cries are pitched on a higher scale than that to which any human ear is attuned.

At least two gregarious bats, *Antrozous* and *Nyctinomus*, are quite noisy in their daytime haunts, squeaking almost continually as they jostle one another restlessly. Coues (1867, p. 284) mentions the squeaking and scratching of *Antrozous pallidus* in the chinks of the officers' quarters at Fort Yuma. When sleeping out-of-doors near a loft occupied by a colony of Pacific pallid bats, the present writer has often heard their shrill voices far into the summer night.

Enemies of Bats

It is axiomatic that the birth-rate of a species is indicative of the relative degree of danger to which its individuals are subject. Among bats the usual number of young is but one or two at a birth, and but one litter is produced annually. Hence it may be taken for granted that bats have but comparatively few enemies. Three reasons may be advanced to account for this comparative immunity from enemies, namely: the probably unpalatable flavor of bats, as suggested by their odor; the comparative safety and remoteness of their diurnal retreats; and the fact that they are both volant and crepuscular. In this connection it may be observed that a comparatively slow rate of reproduction is to be found also among nighthawks and owls, which likewise fly at twilight or nocturnally.

C. H. Merriam (*in* Murphy and Nichols, 1913, p. 10) says: "Bats have been found in both owl and hawk pellets a number of times, but only rarely in hawks'. They have been found also in the stomachs of large trout, and it goes without saying that they are sometimes discovered and eaten by some of the smaller predatory carnivores."

Seton (1909, p. 1181) says: "At Chilliwack Lake, in British Columbia, the rainbow trout are of great size, eight pounds to twelve pounds, and these giants were often seen by Professor John Macoun, leaping after the bats that skim the surface of the lake at evening. In one case he thinks he saw a bat captured by the trout, and is satisfied that the fish would not jump so persistently if they did not frequently succeed." This is of interest, but obviously inconclusive.

Fisher (1893) records the results of the examination of the stomach contents of 2690 hawks and owls inhabiting the United States, including forty-nine species and subspecies. In this list (p. 180) we find but one mention of the bat, a single silvery-haired bat (*Lasionycteris*) that was found in the stomach of a great horned owl. Altum (1863, pp. 43, 217) records the examination of 703 pellets disgorged by European barn owls, among which were found a total of 2551 skulls, sixteen being of bats.

Barrows (1884, p. 29), in a paper on birds of the Lower Uruguay River, South America, states that at night the deserted corridors of the college at Concepcion was one of the barn owl's favorite hunting-grounds for bats. Bailey (1905, p. 211) states that he found two lower jaws of the large brown bat in pellets under the nest of a great horned owl in Texas. Miller (1904, p. 337), in an article on Cuban bats, mentions an individual barn owl which fed largely on bats.

It has been stated to the author that house cats find the bodies of bats unpalatable. No opportunity has been found for experimentation along this line.

It is clear that the enemies of bats are few; only one seems to make more than slight inroads upon their numbers. This enemy is man, who is often guilty of wholesale destruction of individuals of gregarious species. Where colonies of bats have taken possession of attics, barns, or church steeples they are often ruthlessly destroyed when once their squeaking, or the disagreeable odor emanating from their haunt, has betrayed them. A simple method of disposing of a colony of bats which has proved a nuisance is to board up, or screen over, all the entrances to such retreats in the evening when the occupants are on the wing.

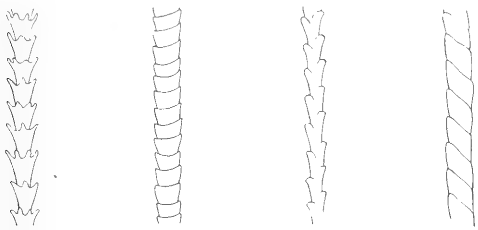
Economic Value of Bats and their Conservation

Many detailed studies have been made and much written to show the value of our insectivorous birds. As much more might be written to show the economic value of our bats. For the latter are undoubtedly as important in keeping in check crepuscular and nocturnal insects as the birds are in destroying day-flying species. Among the insects destroyed there are not only many species which are harmful to agriculture, but also disease-carrying insects, such as the mosquito hosts of malaria.

Dr. C. A. R. Campbell (1913, pp. 1175–1181) has estimated that at Mitchell's Lake, Texas, 90 per cent of the food of bats consists of malaria-carrying mosquitoes. At this place Dr. Campbell built a bat roost in 1911, and during the succeeding two years, when the roost had become populously tenanted, he not only found that the number of mosquitoes had decreased materially but also that malaria had become much less prevalent in the region. In the neighborhood where these experiments were carried on not only were the people much annoyed by mosquitoes before the erection of the roost, but stock also suffered severely, horses and cattle becoming thin and anemic in spite of being well fed. Campbell (1913, p. 1176) believes that the bat itself is protected against the depredations of the mosquito by the peculiar formation of the hairs, which in the bat are not smooth and round, but in appearance likened to a number of morning-glory flowers strung on a straw (fig. A).

Campbell suggests the wisdom of erecting roosts, similar to the one which he has designed, in all parts of the country where mosquitoes are prevalent. He points out that in time the cost of these roosts is defrayed through the value of the guano which may be collected for fertilizer and which has, according to statements submitted by him, a commercial value of about thirty dollars per ton.

It is interesting to note that in at least one city of the United States, San Antonio, Texas, bats are now protected by law. This city, in June, 1914, passed an ordinance to prohibit the destruction of bats within the city limits, and prescribed that anyone violating the provisions of the ordinance should be fined not less than five dollars, or more than two hundred dollars, for each bat so killed.



a *b* *c* *d*

Fig. A. Portion of a hair from the dorsum of *Nyctinomus mexicanus*, no. 19092. × 288.

Fig. B. Portion of a hair from the dorsum of *Eumops californicus*, no. 4326. × 288.

Fig. C. Portion of a hair from the dorsum of *Nycteris cinerea*, no. 20778. × 288.

Fig. D. Portion of a hair from the dorsum of *Myotis longicrus interior*, no. 17790. × 288.

The earliest published record which I have found of the protection of bats because of their usefulness to man is that of J. K. Townsend (1839, p. 325), who says that the great-eared bat (*Corynorhinus*)

> Inhabits the Columbia river district [Washington], rather common. Frequents the store houses attached to the forts, seldom emerging from them even at night. This, and a species of Verpertilio [sic], (V. subulatus,) which is even more numerous, are protected by the gentlemen of the Hudson's Bay Company, for their services in destroying the *dermestes* which abound in their fur establishments.

Origin of California Bats

The bones of bats are so small and delicate that they are very easily destroyed, and it is probably for this reason that they are comparatively seldom found as fossils. In only two instances known to the writer have fossil bats been discovered in California. The palaeontological collection of the University of California contains a skull which I have identified as *Myotis longicrus*, from Samwell Cave, Shasta County; and in the same collection is a broken skull and several lower jaws of *Antrozous pallidus* from Potter Creek Cave, also in Shasta County. In both cases the horizon is doubtfully Pleistocene.

Gregory (1910, p. 319) says of the origin of the bats:

> The group was very highly specialized as far back as the Eocene and the palaeontological evidence as to its origin is therefore of a negative character, as in the case of the Rodents, Edentates and all other groups which probably acquired many of their ordinal characters before the known Tertiary record began. Nevertheless there can be little doubt that the Chiroptera are an offshoot of late Mesozoic or early Tertiary arboreal Insectivores, which must have resembled *Galeopithecus* in many characters.

It is of interest to note the present world-distribution of the eleven genera of bats found within the State of California. The ranges here given are from Miller (1907). Four genera occur in both the Old World and the New. These are: *Myotis*, found in both hemispheres to the northern and southern limits of tree growth; *Pipistrellus*, found in the Eastern Hemisphere to the limits of tree growth, but in the Western Hemisphere confined to North America from the northern United States (except in the Boreal zone) to southern Mexico; *Nyctinomus*, found in the warmer portions of both the Eastern and the Western hemispheres; and *Eptesicus*, found in Africa, Madagascar, Australia, Asia (except the Malay region), and America from southern Canada southward (except Lesser Antilles).

Of the seven genera confined to the New World, *Nycteris* is the most widely distributed, occurring in North America northward to the limit of tree growth and southward to include the Bahama Islands and Greater Antilles, as well as the Galapagos and Hawaiian Islands. *Lasionycteris* occupies northern North America, south through the United States. *Antrozous* is found in western North America from the Columbia River to central Mexico. *Corynorhinus* occurs throughout the warmer portions of North America to southern Mexico. *Macrotus* occurs in the warmer parts of North America from Guatemala to southern California and Arizona, also in the Greater Antilles and the Bahama Islands. *Eumops* is found in the warmer parts of America north to the southwestern United States, and in the Greater Antilles. *Euderma* is the most closely restricted of our genera, having so far been found only in the southwestern United States.

The genera of bats now occupying California may be inferred to have reached their present location from three different sources. First, cosmopolitan genera, namely *Myotis, Eptesicus, Nyctinomus* and *Pipistrellus* probably originated in the Old World. Second, *Nycteris, Lasionycteris, Antrozous* and *Corynorhinus* probably originated in temperate North America. Third, *Macrotus* and *Eumops*, southern genera, probably originated in tropical America and now reach their northernmost limit along the southern edge of our state. With the second group may be classed the genus *Euderma*, now confined to the extreme southwestern United States, and most closely related to the genera *Corynorhinus* and *Plecotus*, of the temperate zones.

Geographic Distribution of Bats

Bats occur throughout the eastern and western hemispheres to the northern and southern limits of tree growth (Miller, 1907, p. 43). Their day-time haunts vary from the cool, humid depths of mountain caves or tunnels to the torrid and arid rock-crannies of the desert. Their nocturnal foragings must involve extremes of temperature and humidity equally as great. When each species is considered separately, however, we find it to be nearly, if not quite, as strictly limited in range as are other mammals, and this in spite of better powers of locomotion.

It has been so generally supposed that bats show far less geographic variation than do other small mammals that the opinion of two recent workers in the order Chiroptera may properly be quoted here. One of these, Barrett-Hamilton (1910, p. 20), says:

> Neglect of bats is a grave error in studying geographical distribution, since, inasmuch as these creatures are possessed of the power of surmounting obstacles which to other mammals must be insuperable, their permanent restriction to definite regions must be due to causes of fundamental importance. And, whereas the wings of bats should have enabled them to occupy with uniformity the entire extent of the British Islands, we find in fact that their distribution therein is not less restricted than that of other mammals.

The second authority, Andersen (1912, p. lxxvi), observes:

The evidence afforded by the geographical distribution of Bats has generally been considered of doubtful value; hence they have either been entirely excluded from the material worked out by zoogeographers or at least treated with pronounced suspicion, as likely to be more or less unreliable documents of evidence. This unwillingness or hesitation to place Bats on an equal zoogeographical footing with non-flying Mammalia would seem to be due, partly to the preconceived idea that owing to their power of flight Bats must evidently have been able easily to spread across barriers which, in ordinary circumstances, are insuperable for wingless Mammalia; partly to the fact that hitherto very often whole series of distinct forms have been concealed under one technical name. So long as (to mention only three cases among many) "*Macroglossus minimus*" was believed to range unchanged from the Himalayas to New Guinea, Australia, and the Solomon Islands (now two distinct genera, thirteen recognizable forms), or "*Cynopterus marginatus*" over India, Ceylon, Indo-China, and Indo-Malaya (now six species, fourteen forms), or "*Rhinolophus ferrum-equinum*" uniformly over Europe, Asia, and Africa (now numerous distinct forms), they were undoubtedly of questionable value as zoogeographical material. But these and similar anomalies invariably disappear as soon as modern methods of discrimination applied on vastly increased material render it possible to draw the lines of separation between the species (and their local modifications) somewhat more closely in accordance with the lines drawn by Nature. The second argument referred to above, that the spreading of Bats from one locality to another must obviously have been greatly facilitated by their possession of wings, may in theory appear plausible enough, but when tested on the actual distribution of the species and subspecies it proves to be of much less importance than commonly supposed; it rests, in reality, on a confusion of two different things: the power of flight no doubt would *enable* a Bat to spread over a much larger area than non-flying Mammalia, but, as a matter of fact, only in very few cases is there any reason to believe that it has *caused* it to do so.

Matthew (1915, p. 227) remarks with regard to this paragraph:

The belief that bats are more easily able to cross ocean barriers than non-flying mammals is probably based, not on the preconceived idea that they could, but upon the plain fact that they have done so far more frequently. Birds and bats are found upon numerous oceanic islands where no non-flying mammals, and very few non-flying animals at all, exist. That they have wings and occasionally use them for so long a journey, whether voluntarily or involuntarily, is a natural explanation. I cannot see any other reasonable interpretation of the fact that they are present and the terrestrial mammals absent in so many remote oceanic islands. With bats, as with most birds, the intervening ocean acts as a hindrance, but their wider distribution shows that it is less of a hindrance than with terrestrial mammals.

Matthew's comments are good, so far as they go, but it seems to the present writer that he has missed the main point of the thesis, which is, that conditions of temperature and humidity limit the distribution of bats as strictly as they do that of other groups of mammals. Of course, given a chain of islands of *identical climatic conditions,* the distribution of bats would without doubt be more uniform than that of non-volant mammals; but were each of these islands to exhibit a unique condition of temperature and humidity, it may be ventured that the bats inhabiting them would be found to represent distinct races, just as do birds in similar cases.

In California there is not a single obvious barrier to the distribution of any species of bat; yet not one of the thirty-one forms inhabiting the state has been found to be distributed uniformly throughout the entire area. In the most abundantly represented genus, *Myotis,* at least fourteen forms are to be recognized, each strictly limited in the breeding season to a certain zonal and faunal area. To illustrate the point: *Myotis orinomus* has never been taken outside of the semi-arid region of the higher portion of the Upper Sonoran zone.

Dentition

Young bats are born with a complete milk-dentition, the function of which is probably to enable them to hold on to their mothers. These teeth differ both in number and form from those of the permanent set. They are homodont, slender, and sharply recurved, and resemble the teeth of seals and cetaceans more nearly than those of adult bats (Barrett-Hamilton, 1910, p. 15).

The permanent teeth consist, as in other mammals, of four kinds: incisors, canines, premolars, and molars. These teeth differ widely among the different genera and species, in both numbers and form, there being, for example, but twenty teeth in the jaws of the blood-sucking genus *Desmodus,* and these so specialized that it would be impossible for the animal to masticate; while the highest number of teeth present in any known bat is thirty-eight (Miller, 1907, p. 23), the number present in the genus *Myotis.*

In several of the species here listed some of the teeth are so minute as to be functionless and are difficult to find; in fact they sometimes drop out of the jaw. In *Nyctinomus mexicanus,* for instance, the number of incisors appears to be variable; and in *Myotis occultus* the middle upper premolar, normally present among related species, is lacking in half the known specimens.

Coloration

In common with other nocturnal or crepuscular mammals bats have, as a rule, a much more sober coloring than diurnal mammals, birds or reptiles, being for the most part of somber grays or browns, with the ventral surface a lighter tint of the same color that pervades the back. Among exotic bats there are notable exceptions to this rule, but among our Californian species only two diverge in color from the quiet tones of their fellows. These are the spotted bat (*Euderma maculatum*), which is black on the dorsal surface, with three large white patches; and the western red bat (*Nycteris borealis teliotis*), which varies in color from bright rufous-red or fawn to yellowish gray.

Young bats, while of the same general color as adults of the same species, are usually darker and duller than their parents.

All color names used in the following pages are taken from Ridgway's *Color Standards and Color Nomenclature* (1912).

Age Variation

In determining the age of bats the writer has followed the suggestion of Miller (1897*b*, pp. 8–9), who finds that in adults the finger joints are small and compact, the epiphyses no longer visible, and the phalanges of essentially the same diameter throughout; whereas in young specimens the joints are "large and loosely formed, with epiphyses separate from the ends of the phalanges and metacarpals, both of which are distinctly enlarged for some distance from the joint."

The matter of determining the age of individuals is important because of the fact that young bats, even when nearly full grown, present characters different enough from those of the adults to cause confusion in identification. In general, the fur of immature specimens is shorter and more woolly than that of adults, and the color is darker and duller. The young of *Lasionycteris*, however, are a notable exception to this rule, the pelage of young examples being long and silky, and the hairs having beautiful silvery tippings, which in the adults are less perfectly shown.

Sexual Variation

There is but little sexual variation among North American bats, and in those inhabiting California I have found such as is present to consist only of a slightly greater average size of the females in a few of the species, for example, in *Pipistrellus*.

Nomenclature

The nomenclature here used is for the most part that adopted by Miller (1912). Where it has seemed necessary to deviate from this standard, an explanation is given in the account of the species concerned under the heading Synonymy and History.

Classification

All bats are included in the order Chiroptera and are in common distinguished by the following characters:

Mammals with the front limbs modified for true flight, the fingers greatly elongated (the third usually at least equal to head and body) and joined together by a membrane which extends to sides of body and legs; shoulder girdle much more developed than pelvis, the sternum usually keeled; knee directed backward owing to rotation of leg for support of wing membrane (Miller, 1907, p. 43).

The families of bats fall naturally into two main groups, the Megachiroptera and the Microchiroptera. The first of these groups, the Megachiroptera, or fruit-eating bats, represents an evolutionary stage much nearer to ordinary mammals than the latter. Its members are distinguished externally by the presence of a claw on the end of the second digit as well as on the pollex, by the completeness of the ring formed by the margin of the ear, and by the absence of a tragus. Andersen (1912, p. vi), the most recent worker on the group, recognizes 228 genera. These are confined to the tropical and subtropical regions of the Old World, east to Australia, Samoa, and the Caroline Islands. Hence none of them fall within the scope of the present paper. The second group, the Microchiroptera, comprises those bats characterized by the absence of a claw on the second digit, by the incompleteness of the ring formed by the margin of the ear, and by the presence, normally, of a tragus (Miller, 1907, p. 44). The same author (*loc. cit.*, p. 78) recognizes six hundred genera which he has grouped into sixteen families. The Microchiroptera are found in both the eastern and western hemispheres.

Only three of the families listed by Miller occur in the Western Hemisphere north of the Bahama Islands and Central Mexico. These are: the Phyllostomidae, represented in California by a single species; the Vespertilionidae, represented by twenty-six species and subspecies; and the Molossidae, represented by four species. These bats may be identified with the aid of the appended keys, which are wholly artificial and make no pretense of indicating natural relationships. Anyone interested in the classification of the families and genera of bats by means of skeletal and dental characters is referred to Miller's (1907) *The Families and Genera of Bats.*

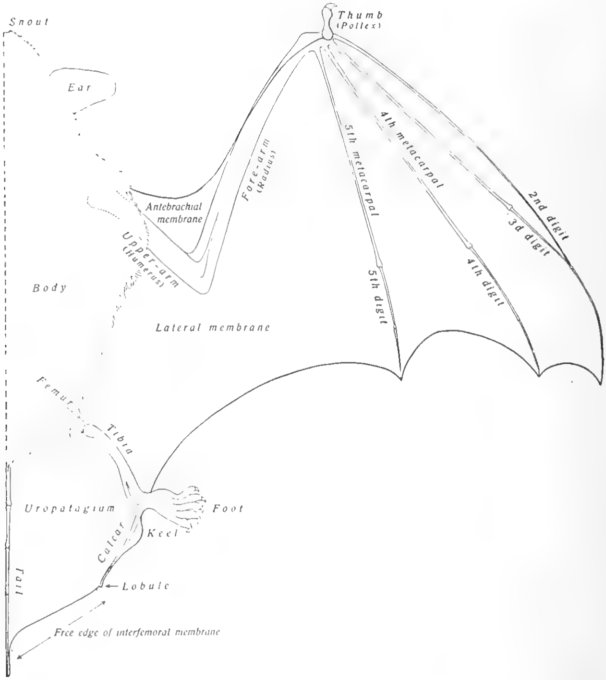


Fig. E. Wing of *Eptesicus fuscus* (drawn semidiagrammatically from specimen no. 23522), × 1.11; labeled to show names of parts, as used in the present paper.

KEY TO CALIFORNIA BATS

I. Based on External Characters

PAGE

1. With noseleaf (see text-fig. F). **Macrotus californicus** 252

1′. Without noseleaf.

  2. Tail extending conspicuously beyond free edge of interfemoral membrane (see pl. 19).

    3. Total length greater than 140 millimeters; no horny excrescences on anterior margin of ear. **Eumops californicus** 370

    3′. Total length less than 140 millimeters; a row of horny excrescences on anterior margin of ear (see text-fig. W).

      4. A fold of membrane extending from the inner third of the femur to the middle of the tibia, forming a pocket at the thigh. **Nyctinomus femorosaccus** 360

PAGE

4′. No fold of membrane extending from the inner third of the femur to the middle of the tibia.

5. Length of forearm more than 50 millimeters. **Nyctinomus depressus** 357

5′. Length of forearm less than 50 millimeters. **Nyctinomus mexicanus** 361

2′. Tail extending at least to edge of interfemoral membrane, but never much beyond (see pl. 18).

6. Nostrils opening forward beneath a conspicuous horseshoe-shaped ridge (see text-fig. U).

7. Length of forearm more than 52 millimeters; color of back yellowish drab brown; habitat west of the desert divides. **Antrozous pacificus** 352

7′. Length of forearm less than 52 millimeters; color of back whitish drab-gray; habitat east of the desert divides. **Antrozous pallidus** 348

6′. Nostrils not opening beneath a horseshoe-shaped ridge.

8. Dorsal surface of interfemoral membrane furred, at least on basal half (see pl. 17, fig. 10).

9. Total length greater than 120 millimeters. **Nycteris cinerea** 330

9′. Total length less than 120 millimeters.

10. General color ranging from rufous red or fawn to yellowish gray. **Nycteris borealis teliotis** 323

10′. General color blackish chocolate. **Lasionycteris noctivagans** 300

8′. Dorsal surface of interfemoral membrane naked except for scattering hairs, or furred only at extreme base.

11. Height of ear from crown more than 25 millimeters.

12. Tragus broadly rounded at tip; back blackish with three white patches (see pl. 16, fig. 9). **Euderma maculatum** 336

12′. Tragus slender, pointed at tip (see text-fig. S); color not blackish and no white markings present.

13. General color wood brown; habitat the arid portions of the Upper and Lower Sonoran zones in southern California. **Corynorhinus rafinesquii pallescens** 340

13′. General color, natal brown; habitat the Upper Sonoran zone in western California. **Corynorhinus rafinesquii intermedius** 344

11′. Height of ear from crown less than 25 millimeters.

14. Tragus short, blunt, and curved forwards (see text-fig. L).

15. General aspect of fur pale grayish; habitat Sonoran zones east of the desert divides. **Pipistrellus hesperus hesperus** 305

15′. General aspect of fur pale brownish; habitat Sonoran zones west of the desert divides. **Pipistrellus hesperus merriami** 311

14′. Tragus not curved forwards, slender.

16. Total length more than 105 millimeters. **Eptesicus fuscus** 314

16′. Total length less than 105 millimeters.

17. Ear when laid forward extending 7 to 10 millimeters beyond nostril. **Myotis evotis** 291

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17′. Ear when laid forward extending less than 6 millimeters beyond nostril.
- 18. Free border of uropatagium distinctly fringed with fine hairs. **Myotis thysanodes** 297
- 18′. Free border of uropatagium faintly or not at all fringed.
  - 19. Length of tibia 15 to 19 millimeters.
    - 20. Length of tibia less than 17 millimeters.
      - Color of back, drab; habitat Lower Sonoran zone east of the desert divides. **Myotis velifer** 259
      - Color of back, light brown; habitat Boreal zone on mountains of east-central and northern California. **Myotis lucifugus altipetens** 263
      - Color of back, dark brown; habitat extreme northern coast belt. **Myotis lucifugus alascensis** 267
    - 20′. Length of tibia more than 17 millimeters.
      - Color of back, yellowish brown; habitat southern Sierra Nevada and mountains of southern California. **Myotis longicrus interior** 271
      - Color of back, dark brown; habitat central and northern Sierra Nevada and humid coast belt. **Myotis longicrus longicrus** 267
  - 19′. Length of tibia less than 15 millimeters.
    - 21. Foot 5 to 6 millimeters in length.
      - Color of back, pale grayish brown; habitat Lower Sonoran zone east of the desert divides. **Myotis californicus pallidus** 288
      - Color of back, bright brown; habitat Upper Sonoran and Transition zones south of the 36th parallel. **Myotis californicus quercinus** 285
      - Color of back, dark brown; habitat Upper Sonoran and Transition zones north of the 36th parallel. **Myotis californicus californicus** 279
    - 21′. Foot 7 to 10 millimeters in length.
      - 22. Height of tragus more than 6.5 millimeters. **Myotis orinomus** 290
      - 22′. Height of tragus less than 6.5 millimeters.
        - Color of back, cinnamon brown; habitat valley of the Colorado River. **Myotis occultus** 261
        - Color of back, light buff; habitat Lower Sonoran zone east of the desert divides. **Myotis yumanensis yumanensis** 273
        - Color of back, buffy brown; habitat Sonoran and Transition zones west of the desert divides. **Myotis yumanensis sociabilis** 276
        - Color of back, dark brown; habitat extreme northern coast belt. **Myotis yumanensis saturatus** 278

II. Based on Skulls and Teeth

PAGE

1. Total number of upper incisors 2.

2. Greatest length of skull 30 millimeters or more; upper incisors diverging at tips (see pl. 20, fig. 22). **Eumops californicus** 370

2′. Greatest length of skull less than 25 millimeters; upper incisors converging at tips.

3. Four teeth in upper jaw behind canine, none minute.

4. Greatest length of skull 19–21 millimeters. **Antrozous pallidus** 348

4′. Greatest length of skull 22–24 millimeters. **Antrozous pacificus** 352

3′. Five teeth in upper jaw behind canine, first one minute.

5. Rostrum longer than wide.

6. Greatest length of skull more than 22 millimeters. **Nyctinomus depressus** 357

6′. Greatest length of skull less than 22 millimeters.

7. Greatest length of skull more than 18 millimeters. **Nyctinomus femorosaccus** 360

7′. Greatest length of skull less than 18 millimeters. **Nyctinomus mexicanus** 361

5′. Rostrum wider than long.

8. Greatest length of skull more than 15 millimeters. **Nycteris cinerea** 330

8′. Greatest length of skull less than 15 millimeters. **Nycteris borealis teliotis** 323

1′. Total number of upper incisors 4.

9. Upper incisors completely filling space between canines. **Macrotus californicus** 252

9′. Upper incisors not completely filling space between canines.

10. Total number of teeth 32. **Eptesicus fuscus** 314

10′. Total number of teeth 34 to 38.

11. Total number of teeth 34.

12. Greatest length of skull less than 15 millimeters.
Pipistrellus hesperus hesperus 305
Pipistrellus hesperus merriami 311

12′. Greatest length of skull more than 15 millimeters. **Euderma maculatum** 336

11′. Total number of teeth 36 or 38.

13. Total number of teeth 36.

14. Sagittal and occipital crests well defined (pl. 21, fig. 30, pl. 22, fig. 42). **Myotis occultus** 261

14′. Sagittal and occipital crests not well defined.

15. Upper surface of rostrum with distinct depression on each side between lachrymal region and external nares. **Lasionycteris noctivagans** 300

15′. Upper surface of rostrum with no depression on each side between lachrymal region and external nares.
Corynorhinus rafinesquii pallescens 340
Corynorhinus rafinesquii intermedius 344

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13′. Total number of teeth 38.
- 16. Greatest length of skull 16 millimeters or more.
  - 17. Sagittal crest well defined; rostrum broad (pl. 21, fig. 32). **Myotis velifer** 259
  - 17′. Sagittal crest not well defined; rostrum slender.
    - 18. Frontal region conspicuously inflated (pl. 21, fig. 35; and pl. 22, fig. 47); zygomatic breadth more than 9.5 millimeters. **Myotis thysanodes** 297
    - 18′. Frontal region not conspicuously inflated (pl. 21, fig. 34, and pl. 22, fig. 46); zygomatic breadth less than 9.5 millimeters. **Myotis evotis** 291
- 16′. Greatest length of skull less than 16 millimeters.
  - 19. Sagittal and occipital crests well defined (pl. 21, fig. 30, and pl. 22, fig. 42). **Myotis occultus** 261
  - 19′. Sagittal and occipital crests not well defined.
    - 20. Dorsal profile of skull distinctly flattened (pl. 22, fig. 38). **Myotis orinomus** 290
    - 20′. Dorsal profile of skull not flattened.
      - 21. Occipital elevation distinct (pl. 22, fig. 40).
        Myotis longicrus longicrus 267
        Myotis longicrus interior 271
      - 21′. Occipital elevation not distinct.
        - 22. Interorbital constriction less than 3.5 millimeters.
          Myotis californicus californicus 279
          Myotis californicus quercinus 285
          Myotis californicus pallidus 288
        - 22′. Interorbital constriction more than 3.5 millimeters.
          - 23. Zygomatic breadth more than 8.5 millimeters; greatest length of skull more than 14 millimeters.
            Myotis lucifugus altipetens 263
            Myotis lucifugus alascensis 267
          - 23′. Zygomatic breadth less than 8.5 millimeters; greatest length of skull usually less than 14 millimeters.
            Myotis yumanensis yumanensis 273
            Myotis yumanensis sociabilis 276
            Myotis yumanensis saturatus 278

AVERAGE MEASUREMENTS OF THE CALIFORNIA SPECIES OF BATS

Arranged in Sequence from Small to Large According to Total Lengths

All Measurements in Millimeters

Species	Number of specimens	Total length	Tail vertebrae	Tibia	Foot	Forearm	Greatest length of cranium
Pipistrellus hesperus hesperus	10 ♂♂, 10 ♀♀	68.6	28.2	10.9	5.1	28.8	11.7
Pipistrellus hesperus merriami	6 ♂♂, 10 ♀♀	72.5	29.1	11.2	5.6	28.0	11.9
Myotis californicus californicus	6 ♂♂, 4 ♀♀	77.6	34.6	13.2	6.4	30.8	13.0
Myotis californicus pallidus	5 ♂♂, 5 ♀♀	80.7	39.6	13.7	6.5	30.2	12.8
Myotis californicus quercinus	2 ♂♂, 8 ♀♀	81.6	36.8	14.1	6.0	31.9	13.1
Myotis yumanensis sociabilis	5 ♂♂, 10 ♀♀	81.7	35.5	14.8	8.6	34.3	13.8
Myotis yumanensis yumanensis	1 ♂	84.0	37.0	14.8	9.5	34.4	13.4
Myotis yumanensis saturatus	1 ♀	84.0	35.0	14.1	8.0	35.0	13.9
Myotis orinomus	5 ♂♂, 5 ♀♀	84.2	39.7	13.2	6.9	32.9	13.9
Myotis lucifugus alascensis	1 ♂	86.0	39.0	15.0	....	35.0	14.9
Myotis lucifugus altipetens	6 ♂♂, 2 ♀♀	86.8	35.6	15.6	10.4	35.8	14.5
Myotis thysanodes	10[1]	87.0	37.0	17.6	8.0	41.2	......
Myotis occultus	1 ♂, 5 ♀♀	87.3	35.6	13.9	8.7	35.6	15.1
Myotis evotis	1 ♀	93.0	43.0	16.6	7.0	37.5	16.2
Nyctinomus mexicanus	10 ♂♂, 10 ♀♀	95.4	34.4	12.3	9.6	41.3	16.9
Myotis longicrus longicrus	2 ♂♂, 4 ♀♀	95.0	43.0	17.9	7.9	37.2	13.9
Myotis velifer	2 ♂♂, 1 ♀	96.6	40.6	15.6	10.0	40.4	16.3
Corynorhinus rafinesquii pallescens	8 ♂♂, 2 ♀♀	97.2	47.7	18.1	9.0	39.9	15.9
Macrotus californicus	18 ♀♀	97.3	37.0	23.0	15.6	49.9	23.1
Myotis longicrus interior	4 ♂♂, 8 ♀♀	98.9	45.7	18.1	7.7	38.0	13.9
Lasionycteris noctivagans	3 ♂♂, 9 ♀♀	102.0	41.1	15.8	9.1	39.2	16.1
Corynorhinus rafinesquii intermedius	12 ♂♂, 8 ♀♀	102.0	48.6	19.7	9.8	42.0	16.2
Nyctinomus femorosaccus	1 ♂[2]	103.0	41.0	......	....	47.0	......
Nycteris borealis teliotis	7 ♂♂, 4 ♀♀	104.5	50.5	18.5	8.5	38.7	12.5
Antrozous pallidus	3 ♂♂, 5 ♀♀	109.3	45.2	19.7	11.6	49.2	20.2
Euderma maculatum	1[3]	111.5	49.5	22.9	7.6	50.8	19.0
Eptesicus fuscus	5 ♂♂, 5 ♀♀	112.4	44.5	17.1	9.5	45.1	18.6
Antrozous pacificus	7 ♂♂, 7 ♀♀	119.0	44.6	19.9	12.9	55.3	22.5
Nyctinomus depressus	1[4]	131.0	52.0	18.0	13.0	60.0	......
Nycteris cinerea	9 ♂♂, 5 ♀♀	135.1	57.7	20.4	11.1	51.8	17.5
Eumops californicus	3 ♂♂, 7 ♀♀	167.1	59.7	22.1	16.8	72.0	31.0

[1] Miller (1897*b*, p. 83); [2] Merriam (1889*a*, p. 23); [3] J. A. Allen (1891*b*, p. 196); [4] Ward (1891, pp. 747–750).

Order CHIROPTERA

Suborder Microchiroptera

Family PHYLLOSTOMIDAE

This family, as represented in North America, includes bats having a simple noseleaf, a tragus, toes (except hallux) with three phalanges each, thumb and foot without sucking disk, and upper incisors not separated by a space in the middle. The only genus which has been found to occur in California is *Macrotus*, which is here represented by a single species.

Genus **Macrotus** Gray

Diagnosis.—Dental formula: i $\frac{2-2}{2-2}$, c $\frac{1-1}{1-1}$, pm $\frac{2-2}{3-3}$, m $\frac{3-3}{3-3} = 34$. Skull with rostrum tapering, and distinctly flattened above; auditory bullae conspicuously enlarged, covering almost the entire cochleae, their greatest diameter being distinctly greater than the width of the space between them. The extremity of the tail projects beyond the hinder edge of the broad interfemoral membrane.

Macrotus californicus Baird

California Leaf-nosed Bat

Macrotus Californicus Baird (1858, pp. 116–117). Original description; type locality Fort Yuma, Imperial County, California.

Macrotus californicus, Baird (1859, II, p. 4, pl. 61, fig. 2). Description; listed from Fort Yuma.

Macrotus californicus, H. Allen (1864, pp. 3–5, figs. 2–4). Description.

Macrotus californicus, Cooper (1868, p. 5). Distribution.

Macrotus californicus, Cooper (*in* Cronise, 1868, p. 442). Description; occurrence near Fort Yuma.

Macrotus waterhousii, Coues and Yarrow (1875, pp. 80–81).

Macrotus waterhousii, Dobson (1878, pp. 464–467), part. Description; occurrence in California; habits.

Macrotus Waterhousei, True (1885, p. 604), part. Range.

Macrotus waterhousei, Bryant (1891*a*, p. 359). Nominal.

Macrotus californicus, H. Allen (1894, pp. 34–43, pls. 1–2). Description; listed from Fort Yuma.

Macrotus californicus, Elliot (1901, pp. 420–421, fig. 93). Diagnosis.

Otopterus californicus, Miller and Rehn (1901, p. 278). Type locality.

Macrotus californicus, Rehn (1904, pp. 441–444). Revision of genus; distribution of *M. californicus*.

Otopterus californicus, Elliot (1904*b*, pp. 653–654). Description; distribution.

Otopterus californicus, Elliot (1905, pp. 509–510). General distribution; type locality.

Otopterus californicus, Stephens (1906, pp. 276–277, 1 fig.). Description; distribution; habits.

Otopterus californicus, Lyon and Osgood (1909, p. 290). Location of type.

Macrotus californicus, Miller (1912, p. 36). Type locality; range.

Macrotus californicus, J. Grinnell (1913*b*, p. 275). Range in California.

Diagnosis.—Size medium (total length 93–103 millimeters); ear reaching beyond tip of muzzle when laid forward; distinct leaf-like vertical appendage on nose; color, above, pale drab to broccoli brown, below, drab, the longer hairs tipped with white.

Description: Head.—Elongate, slender, rostrum rather attenuate; ears oval and slightly hairy, connected at their bases by an incised transverse membrane, when stretched forward exceeding muzzle by one-third entire length of ear; tragus lanceolate, one-third height of ear. Eye almond-shaped. Nose-leaf blunt-lanceolate, higher than width of pad from which it rises (text-figs. F, G). Nostrils crescentic, placed obliquely in nose pad. A triangular pad at apex of chin.

F

G

Fig. F. Side view of head of *Macrotus californicus* (drawn from specimen no. 19127), × 1.00, showing simple nose-leaf, long ears, and erect pointed tragus.

Fig. G. Front view of head of *Macrotus californicus* (drawn from specimen no. 19127), × 1.00, showing position of nostrils in pad at base of nose-leaf, incised transverse membrane connecting bases of ears, and triangular pad at apex of chin.

Limbs and Membranes.—Forearm slightly bowed. Thumb, exclusive of claw, about 7 millimeters in length, and slender. Wing short and stout; length of fifth metacarpal equaling and sometimes exceeding that of third metacarpal. Toes compressed, giving foot a slender aspect. The tail projects beyond edge of interfemoral membrane for the length of one or one and one-half vertebrae. The membranes of this bat are parchment-like rather than leathery, and are not furred.

Pelage.—Fur on body silky; on back about 8 millimeters in length, on under surface about 6 millimeters; ear with posterior base covered with hair of a woolly texture. Interior surface of ear, and proximal three-fourths of anterior border of ear with scattered long hairs.

Color.—In dried specimens the color of the distal third of the hairs on the upper surface varies from pale drab to broccoli brown. The proximal two-thirds is white, and this shows through the darker outer color in irregular patches, due to the parting of the hairs. Fur upon bases of ears grizzled gray throughout. Upon the lower surface of the body the bases of the hairs are white, the distal third drab, tipped with white, this giving a frosted appearance. The membranes in the dried skin are clove brown. In specimens preserved in alcohol the colors are essentially the same, save that the ventral surface lacks the frosted appearance characteristic of dried skins, and the white bases of the hairs are yellowed by the absorption of fat from the body.

Skull.—Rostrum at orbits twice as wide as at canines (pl. 23, fig. 54). Auditory bulla conspicuously enlarged, covering almost entire cochlea (pl. 24, fig. 62), its greatest diameter distinctly greater than width of space between the two bullae.

Teeth.—Dental formula: $i\,\frac{2-2}{2-2},\ c\,\frac{1-1}{1-1},\ pm\,\frac{2-2}{3-3},\ m\,\frac{3-3}{3-3}=34$. Upper incisors conspicuously unequal in size, and completely bridging space between canines; inner pair large, in contact distally, but with roots widely separated; lateral pair small, not extending beyond cingula of inner pair. Lower incisors small and simple, forming a continuous row between canines. Canines strong and simple, with well-developed cingula. Area of anterior upper premolar when viewed from side almost equaling that of posterior tooth. Second upper premolar with main cusp straight, situated at or near middle of crown. First lower premolar higher and broader, when viewed in profile, than second and third, the third the smallest of the three. Second upper molar largest, third upper molar with less than half crown area of second. First lower molar smaller than second.

Measurements.—Average and extreme measurements in millimeters of a series of eighteen females from the Colorado Desert are as follows: total length, 97.3 (93.0–103.0); tail vertebrae, 37.0 (33.0–41.0); tibia, 23.0 (20.8–24.2); foot, 15.6 (14.0–17.0); forearm, 49.9 (46.8–52.6); greatest length of skull 23.1 (22.5–23.7); zygomatic breadth, 11.2 (10.8–11.6); mastoid breadth, 9.8 (9.2–10.0); interorbital constriction, 3.5 (3.4–3.7); height of cranium at bullae, 9.4 (9.3–9.7). The only male at hand measures: total length, 95.0 millimeters; tail vertebrate, 35.0; tibia, 23.0; foot, 14.0; forearm, 48.4; greatest length of cranium, 23.0; zygomatic breadth, 11.1; mastoid breadth, 10.0; interorbital constriction, 3.5; height of cranium at bullae, 9.3.

Synonymy and History.—This bat was described by Baird (1858, p. 116) from a specimen taken at Fort Yuma (Imperial County, California, opposite Yuma, Arizona), under the name *Macrotus Californicus.*

Coues and Yarrow (1875, pp. 80–81), presuming the lighter coloration of *M. californicus* to be due to fading in alcohol, and overlooking other differences, recorded the species occurring in California as identical with *M. waterhousii* of the West Indies. Dobson (1878, p. 465) states that his own conclusion that *waterhousii* and *californicus* are identical was based on descriptions alone, he not having seen the type of *californicus.*

MEASUREMENTS IN MILLIMETERS OF EIGHTEEN FEMALES OF MACROTUS CALIFORNICUS BAIRD, FROM NEAR TORRES (= TORO), RIVERSIDE COUNTY, CALIFORNIA

Mus. no.	Total length	Tail vertebrae	Tibia	Foot	Forearm	Greatest length of cranium	Zygomatic breadth	Mastoid breadth	Interorbital constriction
1206	103.0	38.0	21.5	16.0	48.3	23.6	11.3	10.0	3.4
1207	97.0	39.0	22.0	16.0	50.0	23.6	11.3	10.0	3.4
1208	95.0	37.0	23.2	16.0	50.0	22.7	11.0	......	3.5
1209	100.0	36.0	23.6	17.0	52.6	23.0	11.0	10.0	3.6
1210	95.0	35.0	22.2	16.0	49.9	......	......	......	...
1211	99.0	37.0	22.2	16.0	49.1	22.6	11.3	9.8	3.6
1212	96.0	37.0	23.0	15.0	50.5	22.8	11.3	10.0	3.4
1213	100.0	37.0	24.2	17.0	50.0	23.2	11.0	9.9	3.6
1214	......	......	......	15.0	50.2	23.2	10.8	10.0	3.5
1215	95.0	37.0	22.0	15.0	49.5	22.5	11.4	9.9	3.7
1216	94.0	36.0	20.8	15.0	46.8	23.4	11.3	10.0	3.7
1217	96.0	33.0	22.3	14.0	49.3	23.0	11.1	10.0	3.4
1218	99.0	38.0	21.7	16.0	50.3	23.3	11.2	9.8	3.4
1219	95.0	39.0	22.6	15.0	48.0	23.0	11.0	9.2	3.3
1220	95.0	35.0	23.6	16.0	52.0	23.0	11.2	10.0	3.7
1221	93.0	37.0	23.4	16.0	50.0	22.8	11.0	9.8	3.5
1222	101.0	41.0	23.7	16.0	51.0	23.6	11.4	10.0	3.5
1223	101.0	36.0	23.4	14.0	51.7	23.7	11.6	9.7	3.7

Distribution.—The distribution of *Macrotus californicus* was given by Rehn (1904, p. 441) as throughout the arid region of the southwestern United States, Lower California and Sonora. The species is now recorded from as far eastward as Tombstone, Arizona (Rehn, *loc. cit.*); westward to De Luz, San Diego County, California (see below); south to Camoa, Rio Mayo, Sonora, and Cape San Lucas, Lower California (Rehn, *loc. cit.*); north to Riverside, California (Stephens, MS). In California the leaf-nosed bat seems to be confined to the hottest parts of the Lower Sonoran zone, mainly on the Colorado Desert. (See map, text-fig. H.)

Specimens Examined.—The writer has examined 113 specimens from the following localities in California: San Diego County: Vallecito, 16 (U. S. Nation. Mus., 9; Mus. Vert. Zool., 7); De Luz, 10 (Stanford Univ., 8; U. S. Nation. Mus., 2); Santa Margarita Ranch and River, 17 (Stanford Univ.); Imperial County: Indian Wells, 4 (U. S. Nation. Mus.); Mecca, 2; Palo Verde, 1; Riverside County: Colorado desert near Torres [= Toro], 63.

Natural History.—In September, 1893, Edward Hyatt (MS) captured eighteen specimens of *Macrotus californicus* in a cave on the upper part of the Santa Margarita Ranch, Santa Margarita River, San Diego County. The principal insect remains found scattered about the floor of the cave were of the following beetles, all common

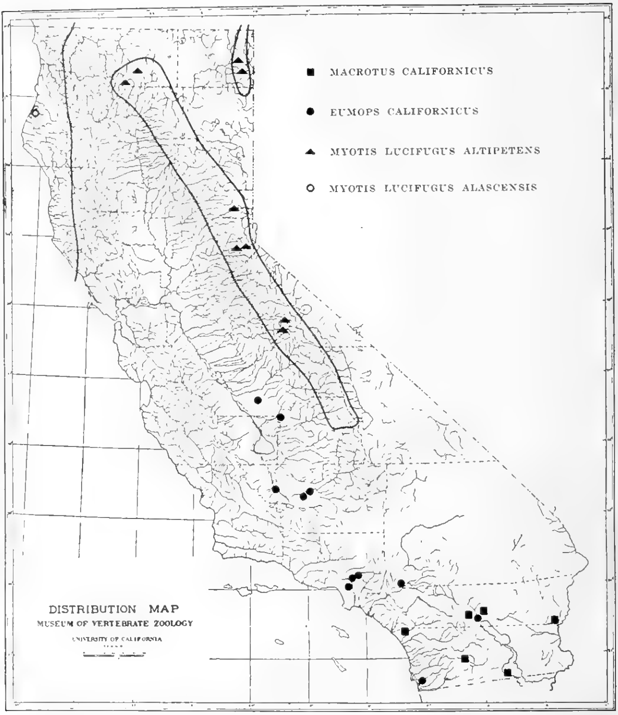

Fig. H. Map showing stations of occurrence in California of *Macrotus californicus*, *Eumops californicus*, *Myotis lucifugus altipetens*, and *Myotis lucifugus alascensis*, as established by specimens examined by the author.

species in southern California: *Ligyrus gibbosus*, *Chlaenius sericeus*, *Polyphylla decemilineata;* also various species of flies.

Sixty-three specimens of this bat were secured by collectors from the California Museum of Vertebrate Zoology on April 15, 1908, in a cave in the Coachella Valley, near Toro, Riverside County (pl. 14, fig. 1). This valley is an old sea-bottom and at sea-level there are several caves worn in the rocky hillside by the one-time action of waves. Eight of these caves were examined by the party and five showed evidence of having been occupied by bats. A portion of the floor of one of these caves was found to be covered to a depth of several inches with bat guano, and this was the cave where all the specimens were obtained. A colony of fully three hundred of these bats was clustered in a funnel-shaped recess in the roof about thirty feet from the entrance. Disturbed by the light of the lantern the bats took wing and streamed out. Of the sixty-three taken, all but two were females and nearly every one contained a single large embryo; none was found to contain more.

In the spring of 1914 the cave referred to above was visited by Donald R. Dickey, who states in a letter that he found it untenanted; but a mile or so away another cave was found which contained a colony of bats. A number of individuals were caught, examined, and liberated. All proved to be California leaf-nosed bats.

On the morning of March 29, 1908, C. H. Richardson (MS) found a female leaf-nosed bat in a mouse trap set on the open ground near Mecca, Imperial County. The bat must have been entrapped while attempting to capture the ants or beetles which commonly visit traps for the oatmeal with which they are baited. It would appear that this species of bat may seek some of its food upon the ground.

Dobson (1878, p. 466) states that a correspondent writing from St. Ann's, Jamaica, remarks that *Macrotus waterhousii* there eats not only insects but also fruits. He mentions particularly the fustic berry (*Morus tinctoria*), the bread-nut (*Brosimum alicastrum*), and the rose-apple (*Eugenia jambos*). It would be very interesting to learn whether our Californian *Macrotus* also eats fruit as well as insects; if so, it is the only fruit-eating bat occurring within the state.

Stephens (1906, p. 277) considers these bats as being probably migratory; for he failed to find them in January in a place where they were nearly always to be found in spring and summer. The writer knows of no dates of capture within the state later than September or earlier than March, save those furnished by Leo Wiley. There is in the Museum of Vertebrate Zoology an alcoholic specimen of *Macrotus californicus* (no. 23651), taken by this observer December 31, 1915, in an old mine shaft near Palo Verde. Mr. Wiley writes (MS) that he secured five more individuals of this species in the same shaft on February 20.

In regard to the usual number of young, Stephens (1906, p. 277) says: "The young are born in June. More than half of the females bear two young, the remainder but one." In the case of the above described colony near Toro all the pregnant females examined contained but one foetus each.

Family VESPERTILIONIDAE

The distribution of this family is the same as that of the order Chiroptera.

The members of this family include bats having muzzles without distinct leaflike outgrowths and having ears with well developed anterior basal lobes; the tragus is simple and usually well developed; the tail is well developed, but extends only to, or but very slightly beyond, the edge of the wide interfemoral membrane.

Miller (1907, p. 196) divides the family into six subfamilies, represented by forty genera. The two subfamilies occurring in America north of southern Mexico are the Vespertilioninae and the Nyctophilinae, and both are represented in California.

Subfamily Vespertilioninae

Distribution same as for the Family. Primitive in structural features, being characterized chiefly by lack of specialized structures distinguishing the other subfamilies. Differs from the Nyctophilinae in the absence, in all of its members, of abrupt truncation of the muzzle, and of any ridge above the nostrils.

Genus **Myotis** Kaup

Representative species of this genus are found in the temperate and tropical regions of both hemispheres; the area of their distribution is probably not exceeded by that of any other genus of bats. About eighty species and subspecies of *Myotis* are now known, fifteen of which occur in California.

Characters.—Dental formula: $i\,\frac{2-2}{3-3},\ c\,\frac{1-1}{1-1},\ pm\,\frac{3-3^*}{3-3},\ m\,\frac{3-3}{3-3} = 38.$ Upper incisors well developed, subequal, and closely crowded; crowns almost cylindrical in cross-section; inner incisor with a distinct posterior secondary cusp, the outer with a well developed concave surface directed toward canine, from which it is separated by a space not

* In at least one species, *Myotis occultus,* the upper middle premolar, pm^2, is sometimes wanting.

quite equal to the combined diameters of both incisors. Lower incisors forming a continuous row strongly bowed forward between canines; first and second lower incisors with rather narrow, trilobed cutting edges, the third much wider than the others and with three or four tubercles. Canines, both above and below, without secondary cusps, but with small yet distinct cingula. The two anterior upper premolars small, especially the central one, which is often minute and crowded out of the tooth-row internally; lower premolars following relative proportions of three upper ones, but central one, although smallest, rarely so minute as corresponding tooth in upper jaw. Last upper molar rather less in area of cross-section than half the second.

The skull varies considerably in size among the different species, but usually has brain-case rounded and elevated above facial region, which is narrow, depressed and markedly saddle-shaped; depth of brain-case, including auditory bullae, about equal to mastoid breadth; sagittal crest low but usually distinct. Auditory bullae well developed and covering more than half the surface of the cochleae, but simple in form and not very large; diameter of bullae about equal to distance between them. Face always hairy; glandular prominences much less developed than in related genera and scarcely adding to breadth of face. Apertures of nostrils, crescent-shaped. Ear oval, distinctly higher than broad. Tragus slender, and nearly or quite straight. Foot, lower leg, and calcar of variable size and development. Wing broad, the fifth metacarpal being slightly longer than, or equal to, third, the posterior attachment anywhere from a little above ankle to base of toes. Tail long, usually exceeding forearm in length.

Myotis velifer (J. A. Allen)

Cave Bat

Vespertilio velifer J. A. Allen (1890, pp. 177–178). Original description; type locality, Guadalajara, Jalisco, Mexico.

Myotis velifer, J. Grinnell (1913*b*, p. 276). Range in California.

Myotis velifer, J. Grinnell (1914, p. 266). Occurrence at Needles, California.

Diagnosis.—According to Miller (1897*b*, p. 57), *Myotis velifer* is the largest species of *Myotis* known to occur anywhere in the United States or Mexico. Total length, 90–105 millimeters; length of forearm, 40–47 millimeters. Calcar slender, without a well developed lobe. Free border of uropatagium naked. Ears short, reaching only to tip of nose. Wing membrane arising from metatarsus.

Description: Head.—Ears short (about 16 millimeters in height) and pointed. Tragus about half height of ear, its anterior edge straight or very slightly concave towards the tip.

Limbs and membranes.—Wing attached nearer to bases of toes than to ankle. Free border of interfemoral membrane shorter than calcar, and naked.

Pelage.—Ears scantily haired over whole ventral surface, as also at extreme bases on dorsal surface. Wings haired on ventral surfaces at their extreme bases; otherwise naked. Uropatagium sparsely haired, both dorsally and ventrally, on its proximal fourth. Toes sprinkled on their dorsal surfaces with stiff hairs from 2 to 3 millimeters long.

Color.—Miller (1897*b*, p. 57) gives the normal coloration of this bat as "dull sepia throughout, paler on the belly, the hairs everywhere dusky slate at base." One specimen at hand from California has the hairs everywhere chaetura black at their bases. On the dorsal surface the distal portions of the hairs are drab, while on the ventral surface the distal portions are cartridge buff. On another skin from California the distal portions of the hairs upon the dorsal surface are avellaneous.

Skull.—Very large and strong for a *Myotis* (see table of measurements); sagittal crest unusually well defined (pl. 21, fig. 32). For comparisons with *M. thysanodes* and *M. evotis*, the only other species with skulls of similar length, see pages 294 and 298.

Measurements.—Average and extreme measurements of the three specimens in the Museum of Vertebrate Zoology are as follows: total length, 96.6 (93.0–100.0); tail vertebrae, 40.6 (40.0–42.0); tibia, 15.6 (15.0–16.0); foot, 10.0 (9.0–10.5); forearm, 40.4 (39.6–41.0); greatest length of cranium, 16.3 (16.0–16.6).

MEASUREMENTS IN MILLIMETERS OF THREE EXAMPLES OF MYOTIS VELIFER (J. A. ALLEN), FROM NEEDLES, SAN BERNARDINO COUNTY, CALIFORNIA

Mus. no.	Sex	Total length	Tail vertebrae	Tibia	Foot	Forearm	Greatest length of cranium	Zygomatic breadth	Breadth of brain-case	Interorbital constriction
7762	♂	100.0	42.0	15.0	10.5	40.8	16.6	10.3	8.1	3.9
7763	♂	93.0	40.0	16.0	9.0	41.0	16.0	10.0	8.1	4.0
7764	♀	97.0	40.0	15.9	10.5	39.6	16.3	10.4	8.3	3.9

Synonymy and History.—The cave bat was described by J. A. Allen (1890, pp. 177–178) under the name *Vespertilio velifer*, from three specimens and six additional skulls obtained at Santa Cruz del Valle, Guadalajara, Jalisco, Mexico. H. Allen (1894, p. 92) placed *velifer* as a subspecies of *Vespertilio albescens* of South America. Miller (1897*b*, p. 59) thinks it best to retain the specific name *velifer* for the bat occurring in Mexico and the United States until the South American species has been definitely characterized.

Distribution.—The general range of this bat as given by Miller (1912, p. 54) is from Hidalgo, northern Michoacan, and the City of Mexico north to the southern border of the United States. In California it has been taken only at Needles, San Bernardino County, in the Lower Sonoran zone near the Colorado River. (See map, text-fig. N.)

Natural History.—Bailey (1905, pp. 208–209) remarks that if this bat is habitually a cave-dweller, the distribution of caves probably accounts for its somewhat erratic range.

Ward (1891, p. 744), in his report of a collecting trip made to Las Vegas, Canton of Jalapa, Vera Cruz, Mexico, in February, 1891, describes a visit made to certain tunnel-like caves on the side of a long extinct volcano. In the cool atmosphere of these caves, freshened by the current of air which continually flowed down the mountain side, bats were found in a state of semi-torpor. The prevailing species was *Myotis velifer*, which was present in hundreds Ward secured one hundred and fifty-two males and forty-two females. The author adds: "This I take to be a fair average of the proportion of the sexes in what is probably one of their permanent headquarters." The three specimens of the cave bat in the Museum of Vertebrate Zoology were taken by C. L. Camp at Needles, California, on July 16 and 18, 1909. Bats of this species were found roosting in numbers in an old storehouse there.

Myotis occultus Hollister

Hollister Bat

Myotis occultus Hollister (1909, p. 43). Original description; type locality, Colorado River, ten miles above Needles, San Bernardino County, California.

Myotis occultus, Miller (1912, p. 55). Nominal.

Myotis occultus, J. Grinnell (1913*b*, p. 276). Range in California.

Myotis occultus, J. Grinnell (1914, pp. 263–265, figs. H, I). Occurrence on the Colorado River.

Diagnosis.—Total length 85 to 90 millimeters, forearm 35.1 to 36.4; calcar longer than free border of interfemoral membrane; wing membrane arising from near bases of phalanges; cranium relatively flat-topped and rostrum broad.

Description: Head.—Form externally not in any way peculiar. In a series of six (dried) specimens the average height of the ear is 11.5 millimeters; of the tragus, 6.1 (both measured from notch).

Limbs and Membranes.—Wing membrane arises from near bases of toes. Calcar longer than free border of interfemoral membrane.

Pelage.—Fur everywhere full and soft. On the body the majority of the hairs are about 3 millimeters long, but scattered among these shorter hairs are occasional longer ones, averaging about 5 millimeters in length. Wings furred only at their extreme bases, both above and below. Uropatagium scantily haired on its basal fifth, the hairs being longer on the dorsal surface than on the ventral. Ear haired on posterior surface at extreme base; a line of hairs extends along basal third of anterior border of ear. Entire anterior surface of ear sparingly haired. Edge of upper lip furnished with a scanty row of downward projecting hairs, and a few longer hairs, 4 to 8 millimeters in length, project from glandular portion of face.

Color.—The six specimens of the Hollister bat which are at hand are quite uniform in coloration. Bases of hairs everywhere chaetura black, except on anterior portion of throat where they are uniform cinnamon buff. Distal portions of hairs on dorsal surface of body light sayal brown, with a silky sheen. This shade of brown extends down onto sides of belly, which are otherwise pale cinnamon buff, varying slightly in exact shade among the different specimens. Membranes clove brown.

Skull.—Easily distinguished from that of any other species of *Myotis* inhabiting California, by its very broad and relatively flat-topped rostrum and brain-case (pl. 21, fig. 30; pl. 22, fig. 42). Saggital crest more clearly defined than in any other Californian *Myotis,* except *M. velifer.* Teeth essentially as described for the genus, save that in four of the eight known specimens the upper middle premolar ($pm^{\underline{3}}$) is missing on both sides.

Measurements.—The average and extreme measurements in millimeters of the six examples of the Hollister bat in the Museum of Vertebrate Zoology are as follows: total length, 87.3 (85.0–90.0); tail vertebrae, 35.6 (34.0–38.0); tibia, 13.9 (13.7–14.0); foot, 8.7 (8.0–9.0); forearm, 35.6 (35.1–36.4); greatest length of cranium, 15.1 (14.8–15.4).

Measurements in Millimeters of Six Examples of Myotis occultus Hollister, from Imperial County, California

Mus. no.	Sex	Total length	Tail vertebrae	Tibia	Foot	Forearm	Greatest length of cranium	Zygomatic breadth	Breadth of brain-case	Interorbital constriction
10702[1]	♀	85.0	35.0	14.0	9.0	35.4	15.2	9.8	7.7	3.9
10703[2]	♀	89.0	34.0	13.8	8.9	35.5	......	9.7	....	4.1
10704[2]	♀	90.0	36.0	14.2	9.0	36.4	15.4	10.1	7.9	4.0
10705[2]	♀	86.0	34.0	13.9	8.5	35.2	14.8	9.6	7.3	4.1
10706[2]	♂	87.0	37.0	13.7	8.0	36.3	15.3	9.6	7.6	4.0
10707[2]	♀	87.0	38.0	14.0	9.0	35.1	15.0	9.8	7.7	4.0

[1] From four miles south of Potholes.
[2] From five miles northeast of Yuma.

Synonymy and History.—The Hollister bat was described by Hollister (1909, p. 43) under the name *Myotis occultus,* from two specimens obtained on the west side of the Colorado River, ten miles above Needles, San Bernardino County, California, May 14, 1905.

Distribution.—Known only from the west side of the Colorado River from near Needles (as above) to near Yuma, where six specimens were obtained in May, 1910 (see J. Grinnell, 1914, p. 263). (See map, text-fig. O.)

Specimens Examined.—The writer has examined eight specimens of the Hollister bat, from the following localities in California: Imperial County: five miles northeast of Yuma, 5; four miles south of

Potholes, 1; San Bernardino County: west side of Colorado River above Needles, 2 (U. S. Biol. Surv.).

Natural History.—J. Grinnell (*loc. cit.*) suggests that the Hollister bat is a late spring arrival in the region where it was found, since Hollister's two specimens were taken in May, and the Museum expedition, although collecting along the Colorado River from February 15 until May 15, failed to detect this bat until the first week of May. This author states that of the six specimens obtained "the first was shot at late dusk close to the river bank between files of cottonwoods, in just the same association as those taken by Hollister. At our second locality of capture, the remaining five specimens were shot over the water in a back eddy of the river. Here these bats arrived in considerable numbers at early dusk to drink, flitting down to the water's surface and dipping several times before flying off among the willows and cottonwoods."

Myotis lucifugus altipetens H. W. Grinnell

High Sierra Bat

Myotis yumanensis saturatus, C. H. Merriam (1899, p. 89). Occurrence on Mt. Shasta.

Myotis yumanensis, Rehn (*in* Stone, 1904*b*, p. 590). Record of specimen from Mt. Tallac.

Myotis yumanensis saturatus, Stephens (1906, p. 267), part. Diagnosis; distribution.

Myotis yumanensis saturatus, J. Grinnell (1913*b*, p. 277), part. Range in California.

Myotis yumanensis altipetens H. W. Grinnell (1916, pp. 9–10). Original description. Type from Merced Lake, Yosemite National Park, California.

Diagnosis.—Length, 79 to 91 millimeters; tibia short, 15.0 to 16.4; distal portion of fur on back isabella color, on belly pale light buff.

Description: Head.—Ear short (about 12 millimeters in height), and bluntly rounded at tip (pl. 18, fig. 15); anterior border straight through lower third, then gently convex to the tip; posterior border slightly concave along upper two-thirds, then convex to basal notch. In a dried specimen at hand the tragus is 6 millimeters in height and slender, varying in width from 1.5 millimeters near the base to 0.5 millimeters just below the rounded tip. Nostrils as in other *Myotis.*

Limbs and Membranes.—Membranes leathery but not thick. Calcar slender and indistinct, greater in length than free border of uropatagium; keel not prominent, and terminating lobule scarcely apparent. Feet large (9 to 12 millimeters in length) and strong, and more than half the tibia in length. The wing arises from a point nearer to bases of toes than to ankle. Claws on both feet and thumbs long, well curved, and of needle-like slenderness.

Pelage.—Fur everywhere full and soft. Longer hairs on middle of back about 7 millimeters in length. Ear haired dorsally only at base, but ventrally short fine hairs scattered sparsely over entire surface. Wing membranes naked save where body fur extends along line of attachment of wings to body. Uropatagium very scantily haired on its ventral surface. Toes scantily haired, both above and beneath, on terminal joints.

Color.—Distal portion of fur on back isabella color; bases of the hairs chaetura black. Ventrally, the bases of the hairs are chaetura black and the tips are a pale tint of light buff. Wings, feet, and membranes deep clove brown, which becomes lighter at posterior edges of wing membranes and uropatagium.

Skull.—Of medium size for the genus (length 14.2 to 15.0 millimeters). Brain-case and rostrum broad and heavily built. Rostrum not sharply turned up at tip, and forehead sloping back very gently. Sagittal crest but faintly indicated, and occipital elevation very slight. The brain-case lacks the inflation at the front which is a character of some other members of the genus. (See pl. 21, fig. 31; pl. 22, fig. 43.)

Measurements.—Average and extreme measurements of a series of eight adult examples of *Myotis lucifugus altipetens* from California are as follows: Total length, 86.8 (79.0–91.0); tail vertebrae, 35.6 (31.0–41.0); tibia, 15.6 (15.3–16.4); foot, 10.4 (9.0–12.0); forearm, 35.8 (35.2–36.5); greatest length of cranium, 14.5 (14.2–15.0).

Synonymy and History.—This species was described under the name *Myotis yumanensis altipetens*, by H. W. Grinnell (1916, pp. 9–10). The type specimen was taken one mile east of Merced Lake, Yosemite National Park, at an altitude of 7500 feet. Four of the five specimens of bats secured by C. H. Merriam (1899, p. 89) in the Hudsonian Zone on Mount Shasta and by him recorded as *Myotis yumanensis saturatus* have been examined by the writer and prove to be *M. l. altipetens*, as does the specimen recorded by Rehn (*in* Stone, 1904*b*, p. 590) under the name *Myotis yumanensis*, from Mount Tallac.

Distribution.—As indicated by the material at hand, the High Sierra bat inhabits the central Sierra Nevada, the vicinity of Mount Shasta, and the Warner Mountains. It occurs chiefly in the Canadian and Hudsonian zones, and has been secured at a greater altitude than any other bat in the collection of the Museum of Vertebrate Zoology. Merriam (1899, p. 89) says of his Mount Shasta specimens: "The species is interesting as the only bat secured in the Hudsonian zone." The following list of localities shows the record stations thus far established in California. (See map, text-fig. H.)

Measurements in Millimeters of Eight Examples of Myotis lucifugus altipetens H. W. Grinnell, from California

Mus. no.	Sex	Locality	Total length	Tail vertebrae	Tibia	Foot	Ear from crown	Forearm	Greatest length of cranium	Zygomatic breadth	Breadth of brain-case	Interorbital constriction
11351	♂	E. face Warren Peak, 8700 ft. alt., Warner Mts., Modoc. Co.	79.0	31.0	......	11.0	10.0	35.5	14.4	8.9	7.6	3.9
11352	♂	E. face Warren Peak, 8700 ft. alt., Warner Mts., Modoc Co.	86.0	33.0	......	12.0	11.0	35.0	14.7	....	7.8	3.8
13805	♂	Castle Lake, 5434 ft. alt., Siskiyou Co.	......	......	15.3	.....	......	35.2	14.7	8.8	7.5	3.9
23035	♂	Vogelsang Lake, 10350 ft. alt., Mariposa Co.	90.0	41.0	16.4	10.0	13.0	36.4	14.2	....	7.3	3.7
23034[1]	♂	1 mi. E. Merced Lake, 7500 ft. alt., Mariposa Co.	88.0	36.0	......	9.0	12.0	36.5	15.0	9.0	7.7	4.0
12036	♂	Gilmore Lake, 8400 ft. alt., Eldorado Co.	......	......	15.0	......	......	36.0	14.5	8.9	7.5	3.9
23036	♀	Vogelsang Lake, 10350 ft. alt., Mariposa Co.	91.0	37.0	......	10.0	14.0	36.0	14.5	9.0	7.8	4.2
13804	♀	Castle Lake, 5434 ft. alt., Siskiyou Co.	......	......	15.7	......	......	36.0	14.3	....	7.5	3.8

[1] Type.

Specimens Examined.—The writer has examined 23 specimens from the following localities in California: Modoc County: east face of Warren Peak, 2; Warner Mts., 1 (Calif. Acad. Sci.); Siskiyou County: Castle Lake, 2; Mt. Shasta, 8 (U. S. Biol. Surv., 4; Mus. Vert. Zool., 4); Nevada County: Independence Lake, 2; Eldorado County: Gilmore Lake, 2; Mt. Tallac, 2 (Mus. Comp. Zool., 1; Acad. Nat. Sci. Phila., 1); Mariposa County: Merced Lake, 2; Vogelsang Lake, 2.

Comparisons.—*Myotis lucifugus altipetens* may be distinguished from *Myotis lucifugus alascensis* by the difference in depth of color; the shade is mummy brown above in *alascensis,* isabella color in *altipetens.* The race *altipetens* is somewhat intermediate in color between the race *carissima* of the Rocky Mountain region, and *alascensis* of the Northwest. Bats of the *lucifugus* group may always be distinguished externally from those of the *longicrus* group by the much longer tibia of the latter (15.0–16.4 in *lucifugus,* 17.9–18.9 in *longicrus*). The skull of *longicrus* has a much shorter, more sharply turned-up rostrum than that of *lucifugus,* and the facial angle is greater (see pl. 22). The separation between the *lucifugus* and *yumanensis* groups is not wide, and identification of young individuals is not possible without the aid of cleaned skulls. Externally, the claws on the foot and thumb are often an aid to identification, being in *lucifugus* much longer, more slender, and more curved. The skull of *yumanensis* is slightly smaller and uniformly more slender than that of *lucifugus,* with the brain-case more inflated in the frontal region.

Natural History.—C. H. Merriam (1899, p. 89) says of the occurrence of the High Sierra bat on Mount Shasta: "Common among the alpine hemlocks at Squaw Creek Camp, where they were seen every night, darting in and out of the flickering light of the camp fire." When camped at Merced Lake and at Vogelsang Lake, in the Yosemite National Park, J. Grinnell and W. P. Taylor secured several of these bats. The former states (MS) that one of the specimens taken was shot at 7:10 on the evening of August 19. This bat, which proved to be a male, was flying high, straight down the canyon between the lodgepole pine tops, and was being pursued by another bat, apparently of the same species. A specimen secured at Vogelsang Lake, altitude 10,350 feet, September 2, was shot at 7:11 P.M., as it was skimming over the surface of the water.

Myotis lucifugus alascensis Miller

Alaska Brown Bat

Myotis lucifugus alascensis Miller (1897*b*, pp. 63–64). Original description; type from Sitka, Alaska.

Diagnosis.—Similar to *Myotis lucifugus altipetens,* but color darker; general color of fur on back mummy brown.

Description.—Feet, ears, and membranes chaetura black, as also the bases of the hairs everywhere. Terminal portion of fur on back mummy brown; on ventral surface tips of hairs drab. Fur on middle of back 6 to 7 millimeters in length. (For comparisons between this and other nearly related races see under *Myotis lucifugus altipetens,* p. 266.)

Measurements.—The single example at hand from California measures in millimeters as follows: total length, 86.0; tail vertebrate, 39.0; foot, 9.0; forearm, 35.0; tibia, 15.0; greatest length of skull, 14.9.

Synonymy and History.—The Alaska brown bat was described by Miller (1897*b*, pp. 63–64), who examined sixteen specimens, thirteen being from Alaska, and the remaining three from Queen Charlotte Islands, British Columbia. The type specimen was procured at Sitka, Alaska.

Distribution.—Miller (1912, p. 55) gives the range of *Myotis lucifugus alascensis* as the humid coast district of southern Alaska and northern British Columbia. The specimen now at hand from California is an adult male (no. 11843, Mus. Vert. Zool.), taken at Eureka, Humboldt County, August 2, 1910 (see map, text-fig. H). I can find no previous record of this race from California.

Natural History.—Nothing is known of the habits of this bat in California.

Myotis longicrus longicrus (True)

Northwestern Long-legged Bat

V[espertilio]. lucifugus, Cooper (*in* Cronise, 1868, p. 442)(?). Occurrence in California.

Vespertilio lucifugus, Cooper (1868, p. 5)(?). Fort Reading (Shasta County).

Vespertilio subulatus, Cooper (*in* Cronise, 1868, p. 442)(?). Listed as occurring in California.

Vespertilio longicrus True (1886, p. 588). Original description; type locality Puget Sound.

Vespertilio lucifugus, C. H. Townsend (1887, p. 182). Record of occurrence at Fort Reading.

Myotis lucifugus longicrus, Miller (1897*b*, pp. 64–65), part. Description; distribution. Specimens listed from Nicasio, Point Reyes, etc.

Myotis lucifugus longicrus, Merriam (1899, p. 89). Occurrence on Mt. Shasta.

Myotis lucifugus longicrus, Elliot (1901, pp. 402–403), part. Diagnosis; distribution.

Myotis lucifugus longicrus, Stone (1904*a*, p. 579). Occurrence on Mt. Sanhedrin.

Myotis lucifugus longicrus, Elliot (1904*b*, p. 581), part. Diagnosis; distribution.

Myotis lucifugus longicrus, Elliot (1905, p. 479), part. Geographic distribution.

Myotis lucifugus longicrus, Stephens (1906, pp. 265–266), part. Diagnosis; distribution.

Myotis lucifugus longicrus, Seton (1909, p. 1149), part. Map showing general range.

Myotis lucifugus longicrus, Miller (1912, p. 55), part. General range.

Myotis lucifugus longicrus, J. Grinnell (1913*b*, p. 276), part. Range in California.

Myotis longicrus, Miller (1914, pp. 211–212). Possible identity of *M. l. longicrus* from interior of California with *M. l. interior.*

Diagnosis.—Total length, 91 to 100 millimeters; tibia long, 17.4 to 18.9; ear from meatus, 12.0 to 13.5; tragus, 7.0 to 8.0; general color of back deep bister.

Description: Head.—Ear short, reaching barely to tip of nose when laid forward, and bluntly rounded at tip. Tragus bluntly rounded at tip, and its greatest diameter about 1 millimeter above its basal notch.

Limbs and Membranes.—Membranes not peculiar. Feet large and strong (7 to 8 millimeters long), but less than half tibia in length. Wing membrane attached at bases of toes. Calcar keeled.

Pelage.—Fur everywhere full and soft; length on middle of back averaging about 7 millimeters. Wing membranes naked save where body fur extends along line of attachment of wings to body. Dorsal surface of uropatagium scantily haired on its basal fourth; ventrally, short, scanty hairs occur over nearly its entire surface. Terminal joint of each toe scantily haired, both above and below. Ear scantily haired over entire anterior surface; posterior surface haired at base, the hairs extending farther outward along anterior margin than on posterior edge.

Color.—Hairs on back deep bister, with faintly lighter tippings. Hairs on ventral surface deep bister at bases, with tippings of vinaceous-buff, these light tippings being more conspicuous toward posterior portion of ventral surface. Ears and membranes dark clove brown. Individuals from the Sierra Nevada of Placer and Eldorado counties are faintly lighter than those from the humid coast belt, and thus vary in the direction of *M. l. interior* of the more arid southern and interior parts of the state.

Skull.—Distinguished from that of any other small *Myotis* by its relatively short and sharply upturned rostrum and very high occipital elevation (pl. 22, fig. 40). Between skulls of the nearly related *Myotis longicrus longicrus* and *M. l. interior* I can find no constant difference; but Miller (1914, p. 211) says of the latter race, "skull tending to be slightly larger than in true *longicrus* and with less abruptly rising frontal and occipital regions; teeth normal."

Measurements.—Average and extreme measurements in millimeters of a series of six adults from California are as follows: Total length, 95.0 (87.0–100.0); tail vertebrae, 43.0 (37.0–47.0); tibia, 17.9 (17.4–18.9); foot, 7.9 (7.5–8.5); forearm, 37.2 (35.7–39.2); greatest length of cranium, 13.9 (13.7–14.2).

MEASUREMENTS IN MILLIMETERS OF SIX ADULTS OF MYOTIS LONGICRUS LONGICRUS (TRUE) FROM CALIFORNIA

Mus. no.	Sex	Total length	Tail vertebrae	Tibia	Foot	Forearm	Greatest length of cranium	Zygomatic breadth	Breadth of brain-case	Interorbital constriction
20811[1]	♀	91.0	42.0	......	7.5	......	13.7	8.4	7.6	3.9
6949[2]	♀	100.0	47.0	18.5	8.0	39.5	14.1	8.8	7.8	4.0
18679[3]	♀	99.0	46.0	17.4	8.5	37.5	13.9	8.9	7.8	4.0
24185[4]	♀	98.0	45.0	18.9	8.0	37.6	14.0	8.6	7.4	4.0
20810[1]	♂	95.0	41.0	17.4	7.5	35.7	13.7	8.6	7.5	4.0
19699[5]	♂	87.0	37.0	17.4	....	35.8	14.2	8.3	7.7	4.1

[1] From Guerneville, Sonoma County.
[2] From Pescadero Creek, San Mateo County.
[3] From Dutch Flat, Placer County.
[4] From Fyffe, El Dorado County.
[5] From Cazadero, Sonoma County.

Synonymy and History.—The northwestern long-legged bat was described by True (1886, p. 588) under the name *Vespertilio longicrus,* from a specimen obtained at Puget Sound.

Distribution.—The California range of *Myotis longicrus longicrus* cannot be confidently stated without much further field work. As will be noted from the list of verified localities, this bat appears to be restricted to the Transition and Upper Sonoran zones in the humid coast belt south as far as Pescadero Creek, San Mateo County, and in the northern portion of the Sierra Nevada, south at least to Walker Lake, Mono County (see map, text-fig. I). The range of *Myotis "lucifugus" longicrus* as given by Miller (1912, p. 55) and J. Grinnell (1913*b,* p. 276) includes that of the newly recognized *Myotis longicrus interior.*

Specimens Examined.—The writer has examined 14 specimens from the following localities in California: Mendocino County: Mt. Sanhedrin, 1 (Acad. Nat. Sci. Phila.); Sherwood, 2; Sonoma County: near Guerneville, 2; near Cazadero, 1; Nevada County: Independence Lake, 1; Placer County: Dutch Flat, 1; Eldorado County: Fyffe, 3; Mono County: Walker Lake, 1; San Mateo County: Menlo Park, 1; Pescadero Creek, 1.

Natural History.—Bats, like birds, have their chosen feeding ranges and the range of one species supplements that of another instead of duplicating it. When encamped near the Russian River in Sonoma County in 1913, I had opportunity to study the feeding

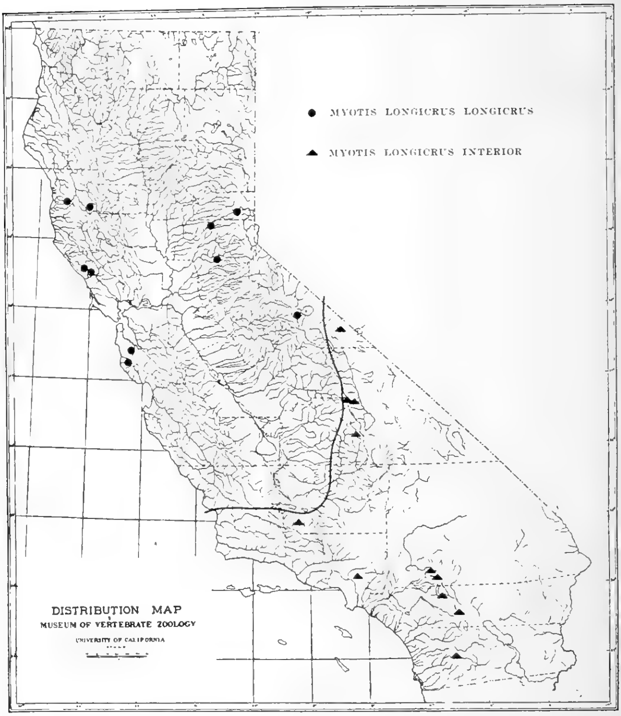

Fig. I. Map showing stations of occurrence in California of *Myotis longicrus longicrus* and *Myotis longicrus interior,* as established by specimens examined by the author.

habits of four species of bats, among them *Myotis longicrus longicrus.* This bat first appeared at 7:45 P.M. (June 11), twenty minutes after sunset, and none was seen after 8:30 P.M. Individuals flew in and out among the tents and young redwoods of the resort at a height of from six to twenty-five feet above the ground. One fly-way, which was used every evening, I was inclined to believe was the route of a single individual.

Myotis longicrus interior Miller

Interior Long-legged Bat

Myotis lucifugus longicrus, Miller (1897*b*, pp. 64–65), part. Description; distribution; specimens listed from San Emigdio, Owens Lake, etc.

Myotis lucifugus longicrus, Elliot (1901, pp. 402–403), part. Diagnosis; distribution.

Myotis lucifugus longicrus, Elliot (1904*a*, p. 318). Occurrence in Inyo Mountains.

Myotis lucifugus longicrus, Elliot (1904*b*, p. 581), part. Diagnosis; distribution.

Myotis lucifugus longicrus, Elliot (1905, p. 479), part. Geographic distribution.

Myotis lucifugus longicrus, Elliot (1907, pp. 504–505). Repeated record.

Myotis lucifugus longicrus, Seton (1909, p. 1149), part. Map showing general range.

Myotis lucifugus longicrus, J. Grinnell (1908, p. 158), part. Occurrence in the San Bernardino Mountains.

Myotis lucifugus longicrus, Miller (1912, p. 55), part. General range.

Myotis lucifugus longicrus, Grinnell and Swarth (1913, p. 380). Occurrence in the San Jacinto Mountains.

Myotis lucifugus longicrus, J. Grinnell (1913*b*, p. 276), part. Range in California.

Myotis longicrus interior Miller (1914, pp. 211–212). Original description; type from Twining, Taos County, New Mexico.

Diagnosis.—Similar to *Myotis longicrus longicrus*, but color tawny-olive, instead of deep bister.

Description.—Bases of hairs everywhere deep bister; distal half of fur on back tawny-olive; on the ventral surface the tippings are of cartridge buff, with the darker bases of the hairs showing through. Ears and membranes clove brown, of a somewhat lighter tint than those of *longicrus*.

Measurements.—Average and extreme measurements in millimeters of a series of twelve examples from California are as follows: Total length, 98.9 (94.0–103.0); tail vertebrae, 45.7 (42.0–49.0); tibia, 18.1 (16.4–19.0); foot, 7.7 (7.0–8.0); forearm, 38.0 (36.8–39.3); greatest length of cranium, 13.9 (13.3–14.4).

Synonymy and History.—The interior long-legged bat was described by Miller (1914, pp. 211–212) from a specimen collected at Twining, Taos County, New Mexico.

Distribution.—Miller (*loc. cit.*) lists specimens of *Myotis longicrus interior* from Nevada, Idaho, Wyoming, Colorado, New Mexico, Arizona, and Chihuahua. The exact range of this bat in California

MEASUREMENTS IN MILLIMETERS OF TWELVE EXAMPLES OF MYOTIS LONGICRUS INTERIOR MILLER, FROM CALIFORNIA

Mus. no.	Sex	Locality	Total length	Tail vertebrae	Tibia	Foot	Forearm	Greatest length of cranium	Zygomatic breadth	Breadth of brain-case	Interorbital constriction
6951	♂	San Bernardino Mts., San Bernardino Co.	95.0	45.0	17.4	7.0	37.0	13.3	8.8	7.7	3.9
6670	♂	San Bernardino Mts., San Bernardino Co.	94.0	42.0	16.4	7.0	37.6	13.9	....	7.7	3.8
17790	♂	Little Onion Valley, Inyo Co.	100.0	46.0	18.6	8.0	39.0	14.0	8.9	7.9	3.8
17791	♂	Kearsarge Pass, Inyo Co.	98.0	49.0	18.5	8.0	39.0	14.4	8.8	7.8	3.9
17788	♀	Little Onion Valley, Inyo Co.	99.0	45.0	18.8	8.0	38.1	14.2	8.9	7.8	4.1
16307	♀	Monache Meadows, Tulare Co.	95.0	43.0	......	7.0	......	14.1	....	7.8	4.0
2041	♀	San Jacinto Mts., Riverside Co.	98.0	44.0	18.0	8.0	38.0	......	....	....	....
2042	♀	San Jacinto Mts., Riverside Co.	103.0	49.0	19.0	8.0	39.0	......	8.5	7.6	4.0
17789	♀	Little Onion Valley, Inyo Co.	101.0	47.0	18.0	8.0	36.8	14.0	8.3	7.6	3.9
2043	♀	San Jacinto Mts., Riverside Co.	102.0	47.0	18.3	8.0	36.6	13.4	8.4	7.5	4.0
6668	♀	Pasadena, Los Angeles Co.	102.0	48.0	18.1	8.0	39.3	14.2	8.6	8.0	4.0
6663	♀	San Bernardino Mts., San Bernardino Co.	100.0	44.0	18.0	7.0	38.4	13.5	8.6	7.6	3.8

cannot at present be given. It has been collected in the arid Upper Sonoran, Transition, and lower Canadian zones, from Benton, Mono County, south to the Cuyamaca Mountains, in San Diego County. (See map, text-fig. I.)

Specimens Examined.—The writer has examined 23 specimens from the following localities in California: Mono County: Benton, 1; Inyo County: Little Onion Valley, 3; Kearsarge Pass, 1; Tulare County: Monache Meadows, 1; Kern County: San Emigdio, 4; Los Angeles County: Pasadena, 2; San Bernardino County: San Bernardino Mts., 4 (Mus. Vert. Zool., 3; Acad. Nat. Sci. Phila., 1); Riverside County: Santa Rosa Mts., 3; base of San Jacinto Mts., near Cabezon, 1; San Diego County: Cuyamaca Mts., 3.

Natural History.—I can find nothing recorded concerning the natural history of this bat.

Myotis yumanensis yumanensis (H. Allen)

Yuma Bat

Vespertilio yumanensis H. Allen (1864, pp. 58–59, figs. 54–56). Original description; type locality, Fort Yuma, Imperial County, California.

Vespertilio Yumanensis, Cooper (1868, p. 5). Distribution.

V[espertilio]. macropus, Cooper (*in* Cronise, 1868, p. 442). Listed as occurring in California.

V[espertilio]. Yumanensis, Cooper (*in* Cronise, 1868, p. 442). Listed as occurring in California.

Myotis yumanensis, Miller (1897*b*, pp. 66–68), part. Description; distribution; recorded from Keeler, Lone Pine, Owens Lake, etc.

Myotis yumanensis, Elliot (1901, p. 403), part. Diagnosis; distribution.

Myotis yumanensis, Miller and Rehn (1901, p. 256). Type locality.

Myotis yumanensis, Elliot (1904*a*, pp. 318–319), part. Occurrence in Argus Mountains.

Myotis yumanensis, Elliot (1904*b*, pp. 576–577), part. Diagnosis; distribution.

Myotis yumanensis, Elliot (1905, p. 475), part. Distribution.

Myotis yumanensis, Stephens (1906, p. 267), part. Diagnosis; distribution.

Myotis yumanensis, Elliot (1907, pp. 501–502), part. Localities of capture in California.

Myotis yumanensis, Lyon and Osgood (1909, p. 291). Record of type.

Myotis yumanensis yumanensis, Miller (1912, p. 56), part. Range.

Myotis yumanensis yumanensis, J. Grinnell (1913*b*, pp. 276–277), part. Range in California.

Diagnosis.—Size rather small (total length 74 to 88 millimeters); calcar distinct, considerably longer than free border of interfemoral membrane, and terminating in a well-marked lobule. Feet very large (7.9 to 9.1 millimeters long) and strong, larger in proportion to size of body than in any other member of the genus *Myotis*. General color of back cartridge buff; of lower surface, whitish.

Description: Head.—Ear when laid forward reaching just beyond tip of nose; tip of ear narrow and abruptly rounded off. Tragus slender, about half height of ear, and pointed, its posterior border crenulate.

Limbs and Membranes.—Membranes thicker than those of other small members of the genus. Foot large, broad, and strong, its length more than half that of tibia.

Pelage.—Hairs longest on middle of back, where they average about 5 millimeters in length.

Color.—An example (no. 171508, U. S. Nation. Mus.) taken at Fort Mohave, Arizona, March 14, 1911, is colored as follows: hairs everywhere blackish at base; terminal half of fur on back and sides cartridge buff; beneath, whitish. Feet, ears, wings, and tail nearest avellaneous of Ridgway's *Color Standards;* wing and tail membranes faintly edged with whitish. A specimen from Carroll Creek, Inyo County, is very similar in coloration, save that the ears, feet, and wing and tail membranes are nearest clove brown. Two specimens (coll. U. S. Nation. Mus.) from Colonia Lerdo, on the Colorado River, below Yuma, in Sonora, Mexico, agree closely in coloration with the Fort Mohave specimen; while a specimen (no. 138556, coll. U. S. Nation. Mus.) from Rancho San Antonio, Lower California, at the west base of the San Pedro Martir Mountains, varies in the direction of specimens of *Myotis yumanensis sociabilis* from Fort Tejon, Kern County, California.

Skull.—Intermediate in size between that of *Myotis californicus* and *Myotis lucifugus* (total length, about 13.4 millimeters). Rostrum and interorbital constriction broader in *yumanensis* than in *californicus*. Skull of *yumanensis* smaller and more slender than skull of *lucifugus*, and brain-case more inflated in frontal region.

Measurements.—The example of *M. y. yumanensis* (no. 16306, Mus. Vert. Zool.) taken at Carroll Creek, Sierra Nevada Mountains, Inyo County, September 9, 1911, measures in millimeters as follows: total length, 84.0; tail vertebrae, 37.0; tibia, 14.8; foot, 9.5; forearm, 34.4; greatest length of cranium, 13.4; zygomatic breadth, 8.0; breadth of brain-case, 7.0; interorbital constriction, 3.8.

Synonymy and History.—This bat was described under the name *Vespertilio yumanensis* by H. Allen (1864, pp. 58–59) from material obtained at Fort Yuma, Imperial County, California. According to Miller (1897*b*, p. 67) this bat is also the *Vespertilio macropus* and *Vespertilio nitidus macropus* of the same author, Dr. Harrison Allen.

Distribution.—Miller (1912, p. 56) gives the range of the species as the Austral zones and lower edge of the Transition zone from the southwestern United States to San Luis Potosi and Michoacan, Mexico. The distribution in California is given by J. Grinnell (1913*b*, pp. 276–277) as follows: Lower and Upper Sonoran zones throughout southern California, both east and west of the desert divides; north through Owens Valley and through the San Joaquin and Sacramento valleys, at least as far as Oroville, Butte County. But this includes also the range of the next described subspecies. A recent examination of the material in the Museum of Vertebrate Zoology showed the existence of a previously unnamed race, *Myotis yumanensis sociabilis*

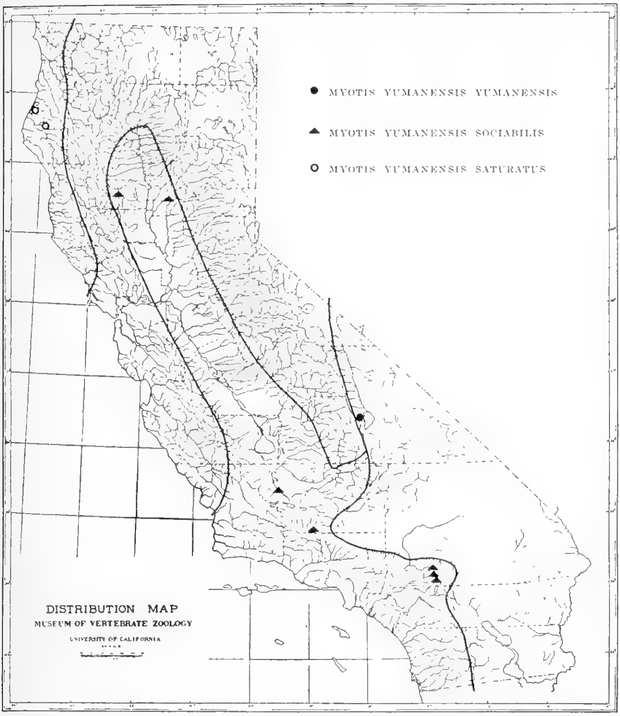

Fig. J. Map showing stations of occurrence in California of *Myotis yumanensis yumanensis*, *Myotis yumanensis sociabilis*, and *Myotis yumanensis saturatus*, as established by specimens examined by the author.

(H. W. Grinnell, 1914, pp. 318–319), west of the desert divides, thus restricting the range of the typical subspecies, *Myotis yumanensis yumanensis*, to the arid Colorado and Mohave deserts and north through the Inyo region, probably altogether within the Lower Sonoran zone. (See map, text-fig. J.)

Specimens Examined.—But a single example of the Yuma bat from California has been examined by the writer: Carroll Creek, Inyo County, 1.

Natural History.—The writer has found nothing published upon the habits of the Yuma bat.

Myotis yumanensis sociabilis H. W. Grinnell

Tejon Bat

Myotis yumanensis, Miller (1897*b*, pp. 66–68), part. Description; distribution.

Myotis yumanensis, Elliot (1901, p. 403), part. Diagnosis; distribution.

Myotis yumanensis, Elliot (1904*a*, pp. 318–319), part. Occurrence at Fort Tejon.

Myotis yumanensis, Elliot (1904*b*, pp. 576–577), part. Diagnosis; distribution.

Myotis yumanensis, Elliot (1905, p. 475), part. Diagnosis; distribution.

Myotis yumanensis, Stephens (1906, p. 267), part. Diagnosis; distribution.

Myotis yumanensis, Elliot (1907, pp. 501–502), part. Localities of capture in California.

Myotis lucifugus longicrus, J. Grinnell (1908, p. 158), part. San Bernardino Mountains.

Myotis yumanensis yumanensis, Miller (1912, p. 56), part. General range.

Myotis yumanensis yumanensis, J. Grinnell (1913*b*, pp. 276–277), part. Range in California.

Myotis yumanensis yumanensis, Grinnell and Swarth (1913, pp. 380–381). Record of capture in the San Jacinto Mountains.

Myotis yumanensis sociabilis H. W. Grinnell (1914, pp. 318–319). Original description; type locality, Fort Tejon, Kern County, California.

Diagnosis.—Similar in general characters to *Myotis yumanensis yumanensis* (H. Allen) and *M. y. saturatus* Miller, but intermediate in color between these two forms.

Description.—Fur distributed as in *M. y. yumanensis;* on middle of back averages about six millimeters in length. Hairs everywhere clove brown at bases; distal half of fur on dorsal surface wood brown; fur below light buff, with darker bases of hairs showing through. On throat, sides and chin the color varies toward warm buff; ears olive brown; feet, wings and tail-membranes clove brown. The young are darker and grayer throughout, entirely lacking the buffy tint of the adults. Specimens of *M. y. sociabilis* from the San Bernardino Mountains show strong superficial resemblance to the smaller individuals among a series of *Myotis longicrus interior* Miller from the same locality. The longer tibia of the latter species, however, together with the slightly greater size of skull and the more elevated occipital region, serves to allocate individuals.

Measurements.—A series of five adult males of *M. y. sociabilis* averages in millimeters as follows: Total length, 81.4 (extremes

75.0–87.0); tail vertebrae, 33.3 (30.0–37.0); tibia, 15.2 (15.0–16.0); foot, 8.1 (7.0–10.0); forearm, 34.6 (32.9–35.3); greatest length of cranium, 13.7 (13.5–14.4); zygomatic breadth, 8.4 (8.0–8.6); breadth of brain-case, 7.1 (6.7–7.6); interorbital constriction, 3.8 (3.5–3.9). Ten adult females from Fort Tejon, Kern County, average in millimeters as follows: Total length, 81.9 (extremes, 76.0–85.0); tail vertebrae, 36.6 (31.0–37.0); tibia, 14.7 (13.5–16.0); foot, 8.9 (8.0–10.0); forearm, 34.2 (33.5–35.0); greatest length of cranium, 13.8 (13.4–14.2); zygomatic breadth, 8.1 (7.8–8.3); breadth of brain-case, 7.2 (6.7–7.3); interorbital constriction, 3.7 (3.5–4.0).

MEASUREMENTS IN MILLIMETERS OF TEN MALES OF MYOTIS YUMANENSIS SOCIABILIS H. W. GRINNELL, FROM CALIFORNIA

Mus. no.	Age	Total length	Tail vertebrae	Tibia	Foot	Forearm	Greatest length of cranium	Zygomatic breadth	Breadth of brain case	Interorbital constriction
6961[1]	juv.	71.0	30.0	12.6	8.0	30.0	......	....	....	....
6639[1]	juv.	82.0	35.0	16.0	9.0	34.5	13.9	....	6.8	3.5
6645[1]	juv.	80.0	36.0	15.0	8.0	33.7	13.5	....	6.9	3.5
6662[1]	juv.	67.0	31.0	12.8	8.0	31.4	......	....	....	....
6636[1]	juv.	82.0	36.0	14.5	8.0	33.7	13.2	7.9	6.7	3.5
6669[2]	ad.	79.0	32.0	15.5	....	35.2	14.0	....	....	....
6665[3]	ad.	83.0	30.0	15.0	....	35.0	14.4	....	7.4	3.8
6667[3]	ad.	87.0	37.0	16.0	7.0	35.3	13.9	8.6	7.6	3.9
6666[3]	ad.	83.0	35.0	15.0	8.0	35.0	14.1	8.6	7.5	....
18485[4]	ad.	75.0	32.0	......	10.0	32.9	13.5	8.0	7.0	3.8

[1] From Fort Tejon, Kern County.
[2] From South Fork Santa Ana River, San Bernardino Mountains.
[3] From Bluff Lake, 7500 ft., San Bernardino Mountains.
[4] From Chambers Ravine, 4 miles north of Oroville, Butte County.

MEASUREMENTS IN MILLIMETERS OF TEN ADULT FEMALES OF MYOTIS YUMANENSIS SOCIABILIS H. W. GRINNELL, FROM FORT TEJON, KERN COUNTY, CALIFORNIA

Mus. no.	Total length	Tail vertebrae	Tibia	Foot	Forearm	Greatest length of cranium	Zygomatic breadth	Breadth of brain-case	Interorbital constriction
6660	85.0	36.0	14.0	9.0	34.0	13.8	8.3	7.3	3.8
6642	81.0	36.0	14.6	9.0	33.8	13.7	8.2	7.3	4.0
6629	76.0	31.0	15.0	9.0	35.0	13.4	7.8	7.0	3.6
6624	81.0	34.0	13.5	8.0	33.5	14.0	8.2	7.0	3.8
6628	82.0	35.0	15.0	8.0	34.5	14.0	....	7.2	3.7
5149	82.0	37.0	15.0	10.0	34.3	13.8	8.0	7.0	3.8
6618	83.0	36.0	14.2	9.0	34.8	14.0	8.0	7.2	3.6
5157	82.0	36.0	14.7	9.0	34.0	13.9	....	7.0	3.5
5158	84.0	36.0	16.0	9.0	33.7	14.2	8.3	7.3	3.8
6616	83.0	34.0	15.0	9.0	34.8	14.0	....	6.7	3.6

Distribution.—The distribution of this bat cannot be stated with confidence without much further field work. It appears to occupy a geographic position intermediate between that of *M. y. yumanensis* and *M. y. saturatus,* namely the semi-arid Transition and Sonoran zones in California west and north of the southeastern deserts. (See map, text-fig. J.)

Specimens Examined.—Total number 69, from the following localities in California: Butte County: Chambers Ravine, four miles north of Oroville, 1; Glenn County: Winslow, five miles west of Fruto, 1; Kern County: Fort Tejon, 61; Buttonwillow, 1 (Calif. Acad. Sci.); San Bernardino County: Bluff Lake, 7500 feet altitude, 3; Bear Lake, 6700 feet altitude, 1; South Fork Santa Ana River, 8500 feet altitude, 1.

Natural History.—July 21 to 25, 1904, J. Grinnell collected sixty-one bats of this species in and about the half-ruined buildings of old Fort Tejon, Kern County. Of the specimens secured, thirty-three proved to be adult females, twelve young females and sixteen young males. There were no adult males in the lot taken. Some of the young males are equal in length to fully adult males from other localities, but their immaturity is attested by the swollen and conspicuous finger joints as well as by the appearance of the pelage. It is possible that with the approach of summer the full-grown males leave the colony and forage singly at higher elevations.

An example of this species of bat (no. 6669, Mus. Vert. Zool.) was taken at an elevation of 8500 feet on the South Fork of the Santa Ana River in the San Bernardino Mountains. This was the highest station for any species of bat secured in those mountains. J. Grinnell (1908, p. 158) erroneously records the taking of this specimen under the name *Myotis lucifugus longicrus.*

Myotis yumanensis saturatus Miller

Miller Bat

Myotis yumanensis saturatus Miller (1897*b*, p. 68). Original description; type locality, Hamilton, Skagit County, Washington.

Myotis yumanensis saturatus, Stephens (1906, p. 267), part(?). Diagnosis; distribution.

Myotis yumanensis saturatus, J. Grinnell (1913*b*, p. 277), part. Range in California.

Diagnosis.—Similar to *Myotis yumanensis yumanensis* and *M. y. sociabilis,* but fur longer, and color darker; general color of back bister.

Description.—A specimen (no. 11844, Mus. Vert. Zool.) taken by F. Stephens at Cuddeback, Humboldt County, California, September 16, 1910, presents the following coloration: Back, nearest bister; lower surface, drab, darkest on chin, throat and sides; membranes, chaetura black. Fur 6 to 7 millimeters long on middle of back.

Measurements.—The above specified example measures: Total length, 84.0; tail vertebrae, 35.0; tibia, 14.1; foot, 8.0; forearm, 35.0; greatest length of cranium, 13.9.

Synonymy and History.—This species was described, under the name *Myotis yumanensis saturatus*, by Miller (1897*b*, p. 68). The type specimen was taken at Hamilton, Skagit County, Washington.

Distribution.—*Myotis yumanensis saturatus* is the dark northwest coast form of the Yuma bat. Miller (1912, p. 56) gives the range of this race as the Transition Zone in Oregon, Washington, and British Columbia. Its distribution in California is given by J. Grinnell (1913*b*, p. 277) as the Transition and Boreal zones in extreme northwestern California, west to Cuddeback, Humboldt County, and east to Mount Shasta. The specimens upon which this statement of the Californian distribution of the Miller bat was based have been examined by the present writer who finds that the examples from Mount Shasta are *Myotis lucifugus altipetens*, as are also the specimens from the same locality recorded under the name *saturatus* by C. H. Merriam (1899, p. 89). [See under *Myotis lucifugus altipetens*, p. 264.] This leaves Eureka and Cuddeback, in Humboldt County, the only verified record stations, within the state. This bat will probably be found to occur at many points within the extreme northwestern portion of California, where humid conditions prevail. (See map, text-fig. J.)

Specimens Examined.—The writer has examined but two specimens of the Miller bat from within the state of California. They were taken at Eureka (no. 11854, Mus. Vert. Zool., August 2, 1910) and Cuddeback (see under Description, above), both localities being in Humboldt County.

Natural History.—Nothing has been recorded concerning the natural history of *Myotis yumanensis saturatus* as occurring in California.

Myotis californicus californicus (Audubon and Bachman)

Little California Bat

Vespertilio californicus Audubon and Bachman (1842, pp. 285–287). Original description; type locality, "California."

Vespertilio nitidus H. Allen (1862, pp. 247–248). Original description; no type designated, but specimens listed from Monterey, California, and Fort Steilacoom, Washington.

Vespertilio nitidus, H. Allen (1864, pp. 60–62, fig. 57–59), part. Description; distribution.

V[espertilio]. nitidus, Cooper (*in* Cronise, 1868, p. 442). Listed as occurring in California.

V[espertilio]. obscurus, Cooper (*in* Cronise, 1868, p. 422) (?). Listed as occurring in California.

Vespertilio nitidus, Dobson (1878, pp. 318–319, pl. 29, fig. 7), part. Description; general distribution (includes "California").

Vespertilio nitidus, H. Allen (1894, pp. 94–104, pl. 12), part. Description; distribution.

Myotis californicus, Miller (1897*b*, pp. 69–72), part. Description; distribution.

Myotis californicus, Merriam (1899, p. 89). Occurrence on Mt. Shasta.

Myotis californicus caurinus, Stone (1904*a*, p. 579). Record of occurrence on Mt. Sanhedrin.

Myotis californicus, Elliot (1901, pp. 403–404), part. Diagnosis; distribution.

Myotis californicus, Elliot (1904*b*, pp. 578–579). Diagnosis; distribution.

Myotis californicus, Stephens (1906, p. 266), part. Diagnosis; distribution; habits.

Myotis californicus, Miller (1912, p. 56), part. Range.

Myotis californicus, J. Grinnell (1913*b*, p. 277), part. Distribution in California.

Diagnosis.—Total length, 74 to 83 millimeters; forearm, 30 to 31.6; foot weak, slender, and less than half length of tibia; calcar about as long as free edge of interfemoral membrane, very slender, edge with a distinct keel, lobed at tip. Free border of uropatagium naked. Ears reaching just beyond tip of nose. Tragus pointed at tip and directed upward, not forward (see text-fig. K). Wing membrane attached at bases of toes. Fur on back distinctly darker at base than at tip; general color of back mummy brown. (See pl. 18, fig. 17).

K L

Fig. K. Side view of head of *Myotis californicus californicus* (drawn from specimen no. 21875), × 1.00, showing erect and acutely pointed tragus.

Fig. L. Side view of head of *Pipistrellus hesperus hesperus* (drawn from specimen no. 10772), × 1.00, showing curved tragus with blunt tip.

Description: Head.—Ear moderately long for the genus (12 to 14 millimeters in height from meatus), and when laid forward reaching from 1 to 3 millimeters beyond tip of nose. Anterior border of auricle straight or slightly convex at base, then strongly convex to a point somewhat beyond middle, thence straight or even a little concave to rounded tip; posterior border concave from tip to a point slightly below middle, thence convex to basal notch; basal lobe strongly developed and notched on its lower border. Tragus straight and tapering, slightly more than half height of ear (text-fig. K).

Limbs and Membranes.—All membranes thin and delicate. Wings attached at bases of toes. Feet small and weak, and usually less than half length of tibia. Calcar slender and usually terminating in a distinct lobe; posterior border provided with a keel.

Pelage.—Fur everywhere full and soft, 5 to 7 millimeters in length on middle of back. Basal third of dorsal surface of ear furred; ventral (inner) side with fine, short hairs sparsely sprinkled over entire surface. Wings naked save for a narrow strip of fur along edge of body. Uropatagium furred on basal third, and on its ventral surface fine scattered hairs nearly to tip of tail. Upper surface of toes sparsely coated with short fine hairs.

Color.—A specimen (no. 12981, Mus. Vert. Zool.) taken in the Yosemite Valley, elevation 4000 feet, May 30, 1911, presents the following coloration: General color of back mummy brown. Hairs on middle of back chaetura black on proximal 4 millimeters, then wood brown for about 1 millimeter, and with a 2 millimeter tip of mummy brown. On dorsal surface of interfemoral membrane and at bases of ears the hairs lack the black bases. On ventral surface of body the hairs are chaetura black at their bases (except those on the interfemoral membrane, which are entirely buffy brown), with the terminal millimeter buffy brown (brightening toward mummy brown on sides of body). Ears, wings, and interfemoral membrane blackish.

Miller (1897*b*, p. 70) gives the typical color of this bat as "light yellowish gray, paler on the belly, the fur everywhere dark plumbeous at base. Membranes, ears, lips, and muzzle blackish." At this time Miller recognized the existence of but one race of *Myotis californicus* within the state of California, and his color description is evidently taken from examples of the pale desert race, *Myotis californicus pallidus.*

Skull.—Small as compared with skulls of other California species of *Myotis* (12.0 to 13.3 millimeters in greatest length), and delicately formed. Brain-case rounded and forehead sloping gently, forming a comparatively deep saddle between brain-case and up-turned rostrum (pl. 22, fig. 36). Interorbital constriction narrow (3.0 to 3.2 millimeters in width). Occipital elevation slight. Skull of same general type as in *Myotis evotis* and *M. thysanodes*, but readily distinguished by its much smaller size. Interorbital constriction (pl. 21, fig. 24) much narrower in *californicus* than in *yumanensis.* In greatest length of cranium *californicus* is only slightly smaller than *orinomus*, but in lateral profile the "flattening" of the skull of *orinomus* (pl. 22, fig. 38) contrasts strongly with the saddle-shape in *californicus* (pl. 22, fig. 36) as formed by the angular outline of the rostrum and forehead.

Measurements.—Ten adult specimens of this bat average in millimeters as follows: total length, 77.6 (extremes, 74.0–83.0); tail vertebrae, 34.6 (29.0–39.0); tibia, 13.2 (12.6–14.0); foot, 6.4 (5.5–8.0); forearm, 30.8 (30.0–31.6); greatest length of cranium, 13.0 (12.4–13.3); zygomatic breadth, 7.6 (7.1–8.1); breadth of brain-case, 6.7 (6.4–7.0); interorbital constriction, 3.1 (3.1–3.2).

Synonymy and History.—The little California bat was described by Audubon and Bachman (1842, pp. 285–287) under the name *Vespertilio californicus.* The describers state: "We have obtained but a single specimen, which was captured at California." Miller (1897*b*, pp. 21–22) has shown the description given by Audubon and Bachman to be applicable to *Myotis californicus* alone among the

Measurements in Millimeters of Ten Adult Examples of Myotis californicus californicus (Audubon and Bachman), from California

Mus. no.	Sex	Locality	Total length	Tail vertebræ	Tibia	Foot	Forearm	Greatest length of cranium	Zygomatic breadth	Breadth of brain-case	Interorbital constriction
18680	♂	Dutch Flat, 3400 ft., Placer Co.	79.0	39.0	13.8	5.5	31.5	13.3	....	6.8	3.1
18681	♂	Dutch Flat, 3400 ft., Placer Co.	77.0	36.0	13.3	5.5	31.0	13.2	....	6.9	3.2
12981	♂	Yosemite Valley, 4000 ft., Mariposa Co.	74.0	36.0	13.4	6.0	30.6	13.0	7.6	7.0	3.1
18904	♀	Blue Cañon, 4600 ft., Placer Co.	81.0	34.0	14.0	5.5	30.7	13.3	7.8	6.7	3.2
19701	♂?	7 miles W. Cazadero, Sonoma Co.	79.0	35.0	13.0	8.0[1]	30.0	......	8.1	7.0	3.2
18490	♀	2 miles SW. Walnut Creek, Contra Costa Co.	74.0	30.0	......	7.0	31.0	12.4	7.5	6.5	3.2
18487	♀	3 miles W. Vacaville, Solano Co.	76.0	29.0	......	7.0	31.6	13.2	7.9	6.7	3.2
20809	♂	1 mile W. Guerneville, Sonoma Co.	75.0	35.0	12.6	6.5	......	12.6	7.1	6.4	3.1
20808	♂	1 mile W. Guerneville, Sonoma Co.	78.0	34.0	13.2	6.5	30.4	13.0	....	6.9	3.1
19700	♀	7 miles W. Cazadero, Sonoma Co.	83.0	38.0	13.2	7.0	31.0	13.0	7.6	6.7	3.1

[1] Probably collector's mistake; in the dried skin the foot measures 5.5 millimeters.

various small bats known to occur within the state of California. He does not, however, indicate to which of the races of *californicus* the name may be taken to apply. According to H. Allen (1894, p. 94), the type is lost. I have here applied the name *californicus* to the race occupying that portion of California north of about latitude 36 degrees and west of the desert divides. H. Allen (1862, pp. 247–248) describes five specimens of *californicus* under the new name *Vespertilio nitidus,* concluding that the description given by Audubon and Bachman is not sufficiently clear to identify the animal. Since the specimen first mentioned by Allen came from Monterey, California, Miller (1897*b*, p. 69) lists *nitidus* as a synonym of *californicus.* Lyon and Osgood (1909, p. 272), however, consider, for reasons which they state, that the type should be regarded as having come from Fort Steilacoom, Washington (where four of the five specimens were secured). In the latter case it would apply to the race of *californicus* now known as *Myotis californicus caurinus* Miller. I have accepted Miller's ruling, whereby *nitidus* becomes a synonym of *californicus.*

I have examined the five specimens from Mount Sanhedrin which were referred to the race *caurinus* by Rehn (*in* Stone, 1904*a,* p. 579) and find them to belong rather to *M. c. californicus,* as here understood.

Remarks.—In a series of fifty skins of the races *californicus* and *quercinus* there is a lack of the uniformity of coloration which so clearly marks the race *pallidus,* and yet the distinctness of the two first-mentioned races cannot be questioned when the mass coloration is considered. A series of seventeen skins of *Myotis californicus californicus,* including both adults and young, taken during July at the one locality, Fyffe, Eldorado County, shows extremes, the paler of which is indeed lighter colored than the darkest *quercinus;* but the mean places the entire series with *californicus,* the latter as represented by a series from west-central California. Stephens (1906, pp. 266–267), a field naturalist of long experience in California, considers bats of the *Myotis californicus* group migratory and states that "a few Bats winter in the Colorado Desert; these appear to be intermediate between *pallidus* and *californicus.*" This statement by Stephens calls to mind certain lines from the paper by Murphy and Nichols (1913, p. 6) on Long Island bats:

> ... We may attribute to the Silver-haired Bat and other bats, a type of migration analogous to that of many birds, in which the individuals of a species within a given breeding range move southward in fall, only to be replaced by winter

residents of the same species coming from a more northerly faunal area. On such a hypothesis, a counter tendency in spring would cause a northward flight of the species as a whole, until each group had reached its native habitat.

The two darkest skins in the Museum series referred to *Myotis californicus quercinus* are autumn specimens, one (no. 6952) having

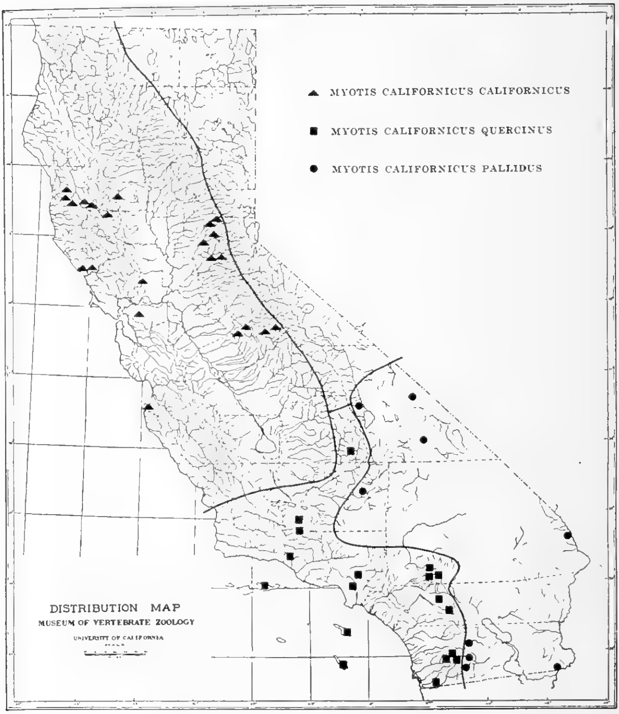

Fig. M. Map showing stations of occurrence in California of *Myotis californicus californicus*, *Myotis californicus quercinus*, and *Myotis californicus pallidus*, as established by specimens examined by the author.

been taken at Pasadena, September 24, and the other (no. 2803) in the Cuyamaca Mountains of San Diego County, August 18. It is possible that these examples are fall migrants of *M. c. californicus*. Much more field work remains to be done before the status and distribution of these subspecies can be stated with confidence.

Distribution.—*Myotis californicus californicus*, as here restricted, occupies that portion of California north of about latitude 36 degrees and west of the Sierran divides. It appears to inhabit exclusively the Upper Sonoran and Transition zones. (See map, text-fig. M.)

Specimens Examined.—The writer has examined 81 specimens (mostly skins with skulls) of *M. c. californicus* from the following localities in California: Mendocino County: Laytonville, 1; Sherwood, 10 (Calif. Acad. Sci., 9; Mus. Vert. Zool., 1); Willits, 1; Mt. Sanhedrin, 5 (Acad. Nat. Sci. Phila.); 3 miles west Mt. Sanhedrin, 1; Glenn County: Winslow, 1; Sonoma County: near Cazadero, 3; near Guerneville, 2; Colusa County: Snow Mt., 1 (Stanford Univ.); Solano County: near Vacaville, 3; Contra Costa County: near Walnut Creek, 4; Monterey County: Monterey, 5; Placer County: Blue Cañon, 1; Dutch Flat, 2; Eldorado County: Fyffe, 28; Limekiln, 1; Michigan Bluff, 2; Placerville, 1 (Stanford Univ.); Mariposa County: Yosemite Valley, 2; El Portal, 2; Pleasant Valley, 4; Coulterville, 1.

Natural History.—When overtaken by a storm in the Yosemite Valley on May 30, 1911, the writer sought refuge in a rocky cavern. A tiny fire was built for comfort and in a few moments a little California bat dropped from a crevice in the roof, evidently overcome by the smoke. The specimen proved to be an adult male and is now no. 12981 (Mus. Vert. Zool.).

A female (no. 18487, Mus. Vert. Zool.), with mammae functional, was taken July 2, 1912, three miles west of Vacaville, Solano County.

Among a series of twenty-eight little California bats in the Museum of Vertebrate Zoology, secured by Joseph Dixon at Fyffe, Eldorado County, during the latter part of July, 1916, there are adults and young of both sexes. The young are nearly full-grown and vary in weight from 2.8 grams to 3.1 grams. The largest of the adult males has a length of 80 millimeters and weighs 3.7 grams, while among the females the greatest length is 80 millimeters, with a weight of 5 grams.

Myotis californicus quercinus H. W. Grinnell

Oak Foliage Bat

Myotis californicus, Elliot (1904*a*, p. 319), part. Occurrence at Fort Tejon and Mt. Whitney, California.

Myotis californicus, Elliot (1907, pp. 502–503), part. Mt. Whitney and Fort Tejon.

Myotis californicus, J. Grinnell (1908, p. 158). Occurrence in the San Bernardino Mountains.

Myotis californicus californicus, Grinnell and Swarth (1913, p. 381). Occurrence in the San Jacinto Mountains.

Myotis californicus quercinus H. W. Grinnell (1914, pp. 317–318). Original description; type locality, Seven Oaks, San Bernardino County.

Diagnosis.—Similar to *Myotis californicus californicus* (Audubon and Bachman) and *Myotis californicus pallidus* Stephens, but intermediate in color between these two forms. Prevailing tone of color on back, cinnamon.

Description.—Ears, feet and fur as in *M. c. californicus.* Membranes and bases of hairs everywhere as in *californicus.* Terminal portions of fur on back, glossy cinnamon, this color extending down onto sides. Terminal portions of hairs on lower surface of body light buff, rather than buffy-brown as in *californicus,* or pale cartridge-buff as in *pallidus.*

Measurements.—A series of ten examples of *M. c. quercinus* from southern California averages in millimeters as follows: Total length, 81.6 (extremes, 77.0–83.0); tail vertebrae, 36.8 (31.0–41.0); tibia, 14.1 (12.5–15.0); foot, 6.0 (4.0–8.0); forearm, 31.9 (31.0–33.2); greatest length of cranium, 13.1 (12.9–13.8); zygomatic breadth, 7.7 (7.4–8.0); breadth of brain-case, 6.8 (6.6–7.0); interorbital constriction, 3.0 (2.9–3.3).

Synonymy and History.—This form was always included under the name *M. c. californicus,* until described by the present writer (1914, p. 317).

Distribution.—The range of *M. c. quercinus,* as so far worked out, occupies portions of the San Diegan faunal division of southern California, and the Santa Barbara Islands. The life-zone is high Upper Sonoran and low Transition. (See map, text-fig. M.)

Specimens Examined.—The writer has examined 41 specimens of *Myotis californicus quercinus* from the following localities in California: San Diego County: Cuyamaca, 2; Julian, 5; Witch Creek, 2 (San Diego Soc. Nat. Hist.); Dulzura, 3 (Amer. Mus. Nat. Hist.); Santa Cruz Island: Friar's Harbor, 3; San Clemente Island, 4; Santa Catalina Island, 1 (coll. F. W. Koch); San Bernardino County: Seven Oaks, 2; Bear Lake, 1; South Fork Santa Ana River, 2; San Jacinto Mountains, Riverside County: Kenworthy, 1; Schain's Ranch, 1; Los Angeles County: Los Angeles, 1 (Amer. Mus. Nat. Hist.); Pasadena, 1; Ventura County: Matilija, 1; Mount Pinos, 2; Tulare County: Trout Creek, 2; Kern County: San Emigdio, 7.

Remarks.—The specimens listed from Santa Cruz, San Clemente, and Santa Catalina islands, while slightly darker than typical *quercinus,* are still nearer to this form than to *M. c. californicus.*

Natural History.—In the San Bernardino Mountains, J. Grinnell (1908, p. 158) found these bats in the Transition Zone, where they were flitting close about the foliage of oaks and pines at late twilight.

MEASUREMENTS IN MILLIMETERS OF TEN EXAMPLES OF *MYOTIS CALIFORNICUS QUERCINUS* H. W. GRINNELL, FROM CALIFORNIA.

Mus. no.	Sex	Locality	Total length	Tail vertebrae	Tibia	Foot	Forearm	Greatest length of cranium	Zygomatic breadth	Breadth of brain-case	Interorbital constriction
6671	♀	Mt. Pinos, 6500 ft., Ventura Co.	82.0	36.0	13.8	6.0	31.6	......	7.8	....	2.9
6940	♀	Friar's Harbor, Santa Cruz Isl.	83.0	36.0	14.0	5.0	32.0	13.0	....	....	3.0
6673	♀	Friar's Harbor, Santa Cruz Isl.	80.0	36.0	15.0	4.0	31.0	12.9	7.4	6.6	3.0
6675	♀	South Fork Santa Ana, 6200 ft., San Bernardino Mts.	82.1	38.0	14.0	7.0	32.3	13.0	7.8	7.0	3.3
6939[1]	♀	Seven Oaks, 5000 ft., San Bernardino Mts.	86.0	41.0	14.2	6.0	31.8	13.3	7.9	6.8	3.0
2780	♀	Julian, San Diego Co.	84.0	39.0	13.7	7.0	31.6	13.5	7.8	7.0	3.1
1894	♂	Kenworthy, 4500 ft., San Jacinto Mts.	79.0	38.0	14.5	6.0	31.4	13.2	8.0	7.0	3.0
2781	♂	Julian, San Diego Co.	83.0	35.0	14.6	8.0[2]	33.2	13.8	....	....	3.1
16301	♀	Trout Creek, 6000 ft., Tulare Co.	77.0	31.0	15.0	5.0	......	12.9	....	6.8	3.2
6672	♀	Bear Lake, 6700 ft., San Bernardino Mts.	80.0	38.0	12.5	6.0	32.7	13.0	7.6	6.8	3.0

[1] Type.
[2] Probably a mistake: in the dried skin the foot measures 6 millimeters.

The breeding season of *M. c. quercinus* is indicated by the following data, taken from specimens in the Museum of Vertebrate Zoology. No. 6675, female with one embryo taken July 3, 1906, on the South Fork of the Santa Ana River, San Bernardino Mountains, 6200 feet altitude; no. 6939, female with one embryo, taken July 8, 1905, at Seven Oaks, San Bernardino Mountains, 5000 feet altitude.

Myotis californicus pallidus Stephens

Little Pallid Bat

Myotis californicus, Miller (1897*b*, pp. 69–72), part. Specimens listed from localities in southeastern California.

Myotis californicus pallidus Stephens (1900, p. 153). Original description; type locality, Vallecito, San Diego County, California.

Myotis californicus pallidus, Elliot (1901, p. 405). Diagnosis.

Myotis californicus pallidus, Miller and Rehn (1901, p. 256). Type locality.

Myotis californicus pallidus, Elliot (1904a, p. 319). Record stations for California: Mesquite Valley and Panamint Mountains, Inyo County.

Myotis californicus pallidus, Elliot (1904*b*, p. 579). Geographic distribution; general characters.

Myotis californicus pallidus, Elliot (1905, p. 477). Geographic distribution.

Myotis californicus pallidus, Stephens (1906, pp. 266–267). Description; distribution.

Myotis californicus pallidus, Elliot (1907, p. 503). Repeated records.

Myotis californicus pallidus, Lyon and Osgood (1909, p. 291). Nature and location of type.

Myotis californicus pallidus, Miller (1912, p. 57). Nominal.

Myotis californicus pallidus, J. Grinnell (1913*b*, pp. 277–278). Range in California.

Myotis californicus pallidus, J. Grinnell (1914, pp. 265–266). Occurrence on the Colorado River; habits.

Diagnosis.—Similar to *Myotis californicus californicus* and *M. c. quercinus,* but averaging slightly smaller, with skull smaller (pl. 21, fig. 25), and color lighter; general tone of back light buff.

Description: Color.—A dry skin of *Myotis californicus pallidus* (no. 7350, Mus. Vert. Zool.) taken by F. Stephens at the type locality, Vallecito, San Diego County, presents the following coloration: Basal 3 millimeters of fur on back, chaetura black, followed by a band of cartridge buff 1 millimeter wide; terminal 3 millimeters, light buff. On dorsal surface of interfemoral membrane the hairs lack the black bases. Fur on ventral surface pale cartridge buff, with blackish bases of hairs showing plainly. Ears, wings and interfemoral membrane vary in color from drab to hair brown.

Measurements.—A series of five males of *M. c. pallidus* averages in millimeters as follows: total length, 81.4 (extremes, 77.0–85.0); tail vertebrae, 40.6 (38.0–44.0); tibia, 13.4 (13.0–14.1); foot, 7.2

(6.0–8.0); forearm, 30.5 (29.5–31.5); greatest length of cranium, 12.8 (12.8–12.9); zygomatic breadth, 7.5 (7.3–7.9); breadth of braincase, 6.6 (6.4–6.8); interorbital constriction, 2.9 (2.8–3.1).

MEASUREMENTS IN MILLIMETERS OF TEN ADULTS OF MYOTIS CALIFORNICUS PALLIDUS STEPHENS, FROM CALIFORNIA

Mus. no.	Sex	Total length	Tail vertebrae	Tibia	Foot	Forearm	Greatest length of cranium	Zygomatic breadth	Breadth of brain case	Interorbital constriction
10700[1]	♂	81.0	40.0	13.0	6.0	31.5	......	7.9	6.8	3.0
16656[2]	♂	82.0	42.0	13.0	8.0	30.0	12.8	7.7	6.7	3.1
17787[3]	♂	77.0	38.0	13.0	7.0	31.5	12.8	7.3	6.4	2.9
19278[4]	♂	85.0	44.0	14.1	8.0	30.0	12.9	....	6.5	3.0
19280[4]	♂	82.0	39.0	14.0	7.0	29.5	......	....	....	2.8
10701[1]	♀	75.0	35.0	14.0	6.0	......	13.2	....	6.3	2.9
16657[2]	♀	81.0	39.0	14.5	7.0	31.5	13.0	....	6.4	3.0
18724[4]	♀	82.0	41.0	13.6	7.0	30.7	12.9	....	6.4	2.9
7350[2]	♀	84.0	40.0	13.9	7.0	31.0	12.5	....	6.4	3.0
19279[4]	♀	78.0	38.0	14.0	7.0	30.4	12.5	....	6.3	2.9

[1] From Colorado River, opposite The Needles.
[2] From Vallecito, San Diego County.
[3] From Lone Pine Creek, 4500 ft., Inyo County.
[4] From La Puerta Valley, San Diego County.

Synonymy and History.—*Myotis californicus pallidus* is the pale desert form of *californicus*. It was described by Stephens (1900, p. 153), from material secured at Vallecito, San Diego County.

Distribution.—Lower Sonoran Zone on the Colorado and Mohave deserts, and north in Owens Valley at least to Lone Pine. (See map, text-fig. M.)

Specimens Examined.—Total number, 15, from the following localities in California: Inyo County: Lone Pine Creek, 1; Mesquite Valley, 1 (Field Col. Mus.); Panamint Mountains, 1 (Field Col. Mus.); Kern County: Redrock Cañon, 1; San Bernardino County: Colorado River, 2; Imperial County: Pilot Knob, 1 (San Diego Soc. Nat. Hist.); San Diego County: La Puerta Valley, 4; Vallecito, 3; Borega Spring, 1 (U. S. Biol. Surv.).

Natural History.—In the spring of 1910 a party of collectors from the Museum of Vertebrate Zoology took four specimens of this bat on the Colorado River and were confident that they saw many others. J. Grinnell (1914, pp. 265–266) states that the specimens secured were all taken at late dusk, considerably later than the bulk appearance of *Pipistrellus hesperus*. Instead of flying high against the sky, as is the habit of the latter species, *M. c. pallidus* was almost always seen low over the bushes of the second bottom, or along shallow washes between clumps of mesquite, seldom appearing above the skyline.

Stephens (1906, p. 266) states that a female little pallid bat captured on April 29 contained one small foetus.

Myotis orinomus Elliot

La Grulla Brown Bat

Myotis orinomus Elliot (1903, pp. 228–229). Original description; type locality, La Grulla, San Pedro Martir Mountains, Lower California.

Myotis lucifugus longicrus, J. Grinnell (1908, p. 158), part. San Bernardino Mountains.

Myotis orinomus, Grinnell and Swarth (1912, pp. 137–142). Occurrence in California.

Myotis orinomus, J. Grinnell (1913*b*, p. 278). Range.

Diagnosis.—Similar in general characters to *Myotis californicus californicus,* but size slightly larger (total length 79 to 88 millimeters), thumb much longer, color paler (tawny olive), cranium flatter and rostrum much broader.

Description: Head.—In general appearance similar to that of *Myotis californicus californicus* but slightly larger. In a series of ten dried skins the ear averages in height 11.5 millimeters from notch, and the tragus 7.0 millimeters in height. Tragus tall, slender and tapering, with tip bluntly rounded.

Limbs and Membranes.—Wing membrane arises from near bases of toes. Calcar longer than free border of interfemoral membrane, and distinctly keeled; in four of ten specimens examined it is lobed at tip.

Pelage.—Fur everywhere full and soft, and of a silky texture on the back. Most hairs on back average about 6 millimeters in length, but scattered among them is a more scanty growth of hairs about 8 millimeters in length. Wing furred only at extreme base, both above and below. Uropatagium scantily haired on basal fifth, both above and below; on its ventral surface short hairs are still more sparingly scattered over the remaining area. Ear haired on basal fifth of posterior surface; also a very scanty growth of fine short hairs extends over entire anterior surface. A few long hairs project from glandular portions of face, and a row of downward projecting hairs extends along upper lip.

Color.—While a small amount of individual variation in color is apparent in the specimens of *orinomus* at hand, the series as a whole bears a very close resemblance in color to a series of *Myotis occultus* from the Colorado River. The hairs are everywhere chaetura black at their bases. On the dorsal surface the color of the distal portion of the fur varies from light sayal brown to tawny-olive. On the sides the darker shade of the back fades gradually into the cartridge buff of the lower surface. The membranes are a dark clove brown.

Skull.—Easily distinguished from that of any other small *Myotis* by reason of its decidedly flattened rostrum and brain-case (see pl. 21, fig. 26, and pl. 22, fig. 38). This flattening has tended to obliterate

MEASUREMENTS IN MILLIMETERS OF TEN EXAMPLES OF MYOTIS ORINOMUS ELLIOT, FROM CALIFORNIA

Mus. no.	Sex	Locality	Total length	Tail vertebrae	Tibia	Foot	Forearm	Greatest length of cranium	Zygomatic breadth	Breadth of brain-case	Interorbital constriction
2044	♂	Garnet Queen Mine, Santa Rosa Mts.	84.0	38.0	13.0	7.0	32.0	.....	8.6	6.8	3.1
2045	♂	Garnet Queen Mine, Santa Rosa Mts.	80.0	37.0	12.3	6.0	30.8	13.5	8.7	6.8	3.1
2046	♂	Garnet Queen Mine, Santa Rosa Mts.	79.0	37.0	12.4	7.0	31.9	13.4	...	6.8	3.2
2047	♂	Garnet Queen Mine, Santa Rosa Mts.	86.0	40.0	13.0	8.0	33.2	14.0	8.7	6.8	3.0
2048	♂	Hemet Lake, San Jacinto Mts.	84.0	40.0	12.8	8.0	32.8	13.7	8.6	6.7	3.0
6941	♀	Doble, San Bernardino Mts.	87.0	38.0	14.0	6.0	34.6	14.5	8.7	6.9	3.1
16300	♀	Walker Pass, Kern Co.	82.0	42.0	13.6	6.5	32.5	13.9	8.2	6.9	3.1
16304	♀	Fay Creek, near Weldon, Kern Co.	88.0	40.0	13.7	7.0	34.1	14.7	8.9	6.8	3.1
16305	♀	Fay Creek, near Weldon, Kern Co.	87.0	40.0	14.0	7.0	33.0	14.1	...	6.7	3.0
16303	♀	Carroll Creek, Inyo Co.	87.0	45.0	13.5	6.0	34.3	14.3	8.7	6.7	3.1

the angle or "saddle" between the rostrum and brain-case, which is shown so clearly in many forms of *Myotis*. The tooth-row (length 5.2 to 5.5 millimeters) is much longer in *orinomus* than in *californicus*.

Measurements.—Average and extreme measurements in millimeters of a series of ten *M. orinomus* are as follows: Five males: total length, 82.3 (extremes 80.0–86.0); tail vertebrae, 38.4 (37.0–40.0); tibia, 12.7 (12.3–13.0); foot, 7.2 (6.0–8.0); forearm, 32.1 (30.8–33.2); greatest length of skull, 13.6 (13.4–14.0). Five females: total length, 86.2 (82.0–88.0); tail vertebrae, 41.0 (38.0–45.0); tibia, 13.8 (13.5–14.0); foot, 6.5 (6.0–7.0); forearm, 33.7 (32.5–34.6); greatest length of cranium, 14.3 (13.9–14.7). A comparison of the above figures will show that the females average somewhat larger than the males.

Synonymy and History.—The La Grulla brown bat was described by Elliot (1903, pp. 228–229) from three specimens obtained in the San Pedro Martir Mountains, Lower California, two being taken at La Grulla and one at Santa Eulalia. The occurrence of this bat in California is first mentioned by Grinnell and Swarth (1912, pp. 138–141).

Distribution.—*Myotis orinomus* has been recorded only from northern Lower California and from southern California, where its range may be defined as the high Upper Sonoran zone, in its semi-arid portion, from the east slope of the Sierra Nevada near Owens Lake south through the southern Sierras and coast ranges to the Mexican line. (See map, text-fig. O.)

Specimens Examined.—The writer has examined 17 specimens of *Myotis orinomus* from the following localities in California: San Diego County: Dulzura, 3 (Amer. Mus. Nat. Hist., 2; Acad. Nat. Sci. Phila., 1); Jacumba, 1 (Amer. Mus. Nat. Hist.); Santa Ysabel, 1 (San Diego Soc. Nat. Hist.); Orange County: Trabuco Cañon, Santa Ana Mountains, 1; Riverside County: Garnet Queen Mine, Santa Rosa Mountains, 4; Hemet Lake, San Jacinto Mountains, 1; San Bernardino County: Doble, 1; Kern County: west slope Walker Pass, 1; San Emigdio, 1; Fay Creek, 2; Inyo County: Carroll Creek, on east slope Sierra Nevada, 1.

Natural History.—Nothing has been recorded of the habits of this species.

Myotis evotis (H. Allen)

Little Big-eared Bat

Vespertilio evotis H. Allen (1864, pp. 48–50, figs. 42–44). Original description; type locality fixed as Monterey, California (see Miller, 1897*b*, pp. 77–78).

Vespertilio evotis, Cooper (1868, p. 5). Distribution.

V[espertilio]. evotis, Cooper (*in* Cronise, 1868, p. 442). Occurrence in California.

Vespertilio evotis, Dobson (1878, p. 324). Description; general distribution; one skin listed from "California."

Vespertilio evotis, Bryant (1891*a*, p. 358). Nominal.

Vespertilio albescens evotis, H. Allen (1894, pp. 89–91), part. Description; distribution; localities of capture in California.

Myotis evotis, Miller (1897*b*, pp. 77–80). Description; distribution; specimens listed from Inyo Mountains, Owens Lake, San Joaquin River, and Twin Oaks.

Myotis evotis, Merriam (1899, p. 88). Occurrence on Mt. Shasta.

Myotis evotis, Elliot (1901, p. 406). Diagnosis; distribution.

Myotis evotis, Stone (1904*a*, p. 579). Record from Mt. Sanhedrin.

Myotis evotis, Elliot (1904*a*, p. 320). Occurrence on Mt. Whitney.

Myotis evotis, Elliot (1904*b*, p. 574). Diagnosis; distribution.

Myotis evotis, Stone (1904*b*, p. 587). Occurrence at Belmont.

Myotis evotis, Elliot (1905, p. 474). General distribution.

Myotis evotis, Stephens (1906, pp. 267–268). Diagnosis; distribution; migration.

Myotis evotis, Elliot (1907, p. 501). Record of occurrence in vicinity of Mt. Whitney, California.

Myotis evotis, Miller (1912, p. 59). Range.

Myotis evotis, J. Grinnell (1913*b*, p. 278). Range in California.

Diagnosis.—Size large for a *Myotis* (length 75 to 93 millimeters); forearm 35.7 to 38.4 millimeters; calcar longer than free border of interfemoral membrane; ear very long, when laid forward reaching from 7 to 10 millimeters beyond snout.

Description: Head.—Ears large (19 to 20 millimeters in height from meatus), thus easily distinguishing this species of *Myotis* from all others occurring in California. Greatest width of ear slightly more than half its length. Anterior border of auricle convex from base to a point slightly beyond the middle, thence straight, or nearly so, to tip; posterior border slightly concave immediately below tip, then gradually convex to base. Tragus long (10 to 13 millimeters), slender, and pointed.

Limbs and Membranes.—Membranes thin and light. Wings attached at bases of toes; third and fifth metacarpals about equal in length. Foot slightly less than half length of tibia. Calcar slightly lobed at tip, and longer than free border of uropatagium. Tail slightly longer than forearm.

Pelage.—Fur everywhere full and soft. Sides of face scantily haired. Anterior border of ear scantily haired on basal fifth. Toes slightly haired both above and beneath. Interfemoral membrane naked save for basal fifth and a few scattering hairs along "nerves" and on free border.

Color.—Two skins from near Pasadena, Los Angeles County (nos. 6685, 6953), have ears and membranes dark clove brown; prevailing tone of back pale honey yellow, with bases of hairs blackish slate; on lower surface of body, outer portion of fur pale olive-buff. One specimen (no. 12037) taken July 29, 1910, at Independence Lake, Nevada County, is somewhat different in coloration, being paler and grayer throughout, with ears and membranes blackish mouse gray.

Skull.—About 16 millimeters in length; slender and delicately built (pl. 21, fig. 34, and pl. 22, fig. 46). Posterior margin of brain-case rounded and occipital ridges but faintly defined. The only other Californian species of this genus which have skulls similar in length to that of *evotis* are *Myotis velifer* and *M. thysanodes.* Upon comparison it will be noted that in *velifer* the rostrum is heavily built, the sagittal crest is distinct, and the posterior margin of the brain-case is truncate, whereas in *evotis* the rostrum is lightly built, the ridges are indistinct and the posterior margin of the brain-case is rounded. The differences between the skulls of *evotis* and *thysanodes* are not so tangible, and it is somewhat difficult to properly allocate skulls of young individuals of these two species. But in adults the brain-case of *thysanodes* is much more inflated than that of *evotis*, the breadth of the brain-case in *thysanodes* is relatively greater, and the rostrum is heavier.

Measurements.—Measurements in millimeters of an adult female (with one embryo) taken near Pasadena, May 29, 1904, are as follows: total length, 93.0; tail vertebrae, 43.0; tibia, 16.6; foot, 7.0; forearm, 37.5; greatest length of cranium, 16.2; zygomatic breadth, 9.1; breadth of brain-case, 7.5; interorbital constriction, 3.7.

Synonymy and History.—*Myotis evotis* was described by H. Allen (1864, pp. 48–50) under the name *Vespertilio evotis.* No type locality was designated by that author, but Miller (1897*b*, p. 78) fixes Monterey, California, as the type locality, selecting one of the localities given by H. Allen. In his monograph of 1894 (pp. 89–91), Allen regards *evotis* as a race of *Vespertilio albescens,* and lists under the same name a specimen of *Myotis thysanodes* (see Miller, 1897*b*, p. 80).

Distribution.—Given by Miller (1912, p. 59) as the Austral and Transition zones from the Pacific coast to the eastern edge of the Rocky Mountains; south to Vera Cruz, Mexico. In California the range of *Myotis evotis* is not well defined as far as shown by the facts yet available. It seems to comprise the Upper Sonoran and Transition zones from the Mexican line northwards as far as Mount Shasta; west to the eastern boundary of Mendocino County, and east to Independence Lake, Nevada County, and the Inyo Mountains, in Inyo County. (See map, text-fig. N.)

Specimens Examined.—Total number, 22, from the following localities in California: San Diego County: Dulzura, 2 (Amer. Mus. Nat. Hist., 1; Acad. Nat. Sci. Phila., 1); Witch Creek, 2 (San Diego Soc. Nat. Hist.); Twin Oaks, 1 (U. S. Biol. Surv.); San Bernardino County: San Bernardino, 1 (San Diego Soc. Nat. Hist.); Los Angeles County: near Pasadena, 2; North Fork San Gabriel River, 1 (L. A.

MEASUREMENTS IN MILLIMETERS OF SEVEN EXAMPLES OF *MYOTIS EVOTIS* (H. ALLEN), FROM CALIFORNIA

Mus. no.	Sex	Locality	Total length	Tail vertebrae	Tibia	Foot	Forearm	Greatest length of cranium	Zygomatic breadth	Breadth of brain-case	Interorbital constriction
6685	♂	Big Santa Anita Cañon, near Pasadena	88.0?	36.0?	16.6	8.0	35.7	16.0	....	7.9	3.9
6953	♀	Arroyo Seco, near Pasadena	93.0	43.0	16.6	7.0	37.5	16.2	9.1	7.5	3.7
12037	♂	Independence Lake, Nevada Co.	......	......	16.8	....	38.4	16.1	....	8.0	3.8
5759	♂	Mt. Tallac, Eldorado Co.	......	......	16.5	....	36.2	......	....	....	....
3283	♂	Mt. Shasta, Siskiyou Co.	91.0	41.0	17.5	....	36.0	......	....	....	3.7
3284	♂	Mt. Shasta, Siskiyou Co.	90.0	43.0	16.1	....	......	......	....	....	3.8
160[1]	♀	Pine Flat, N. Fork San Gabriel River, Los Angeles Co.	75.0	38.0	......	9.0	......	......	....	....	....

[1] Los Angeles County Museum of History, Science and Art.

Co. Mus. Hist. Sci. and Art); Inyo County: Inyo Mts., 1 (U. S. Biol. Surv.); Owens Lake, 1 (U. S. Biol. Surv.); Madera County: North Fork San Joaquin River, 1 (U. S. Biol. Surv.); Santa Clara County: Palo Alto, 1 (Stanford Univ.); Saratoga, 1; San Mateo

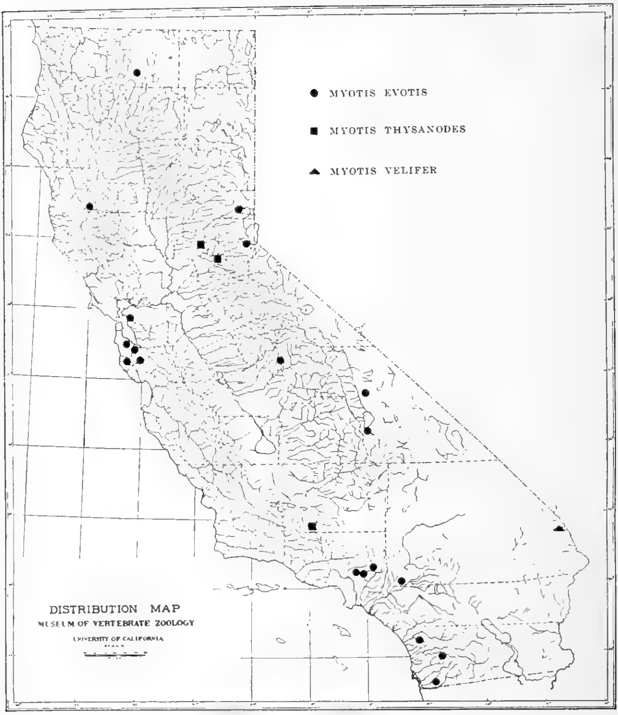

Fig. N. Map showing stations of occurrence in California of *Myotis evotis*, *Myotis velifer*, and *Myotis thysanodes*, as established by specimens examined by the author.

County: Pescadero Creek, 1; Belmont, 1 (Acad. Nat. Sci. Phila.); Alameda County: Berkeley, 1 (U. C. Dept. Zool.); Eldorado County: Mt. Tallac, 2 (Mus. Comp. Zool., 1; Mus. Vert. Zool., 1); Nevada County: Independence Lake, 1; Mendocino County: Mt. Sanhedrin, 1 (Acad. Nat. Sci. Phila.); Siskiyou County: Mt. Shasta, 2.

Natural History.—It is probable that in California this species is migratory and breeds chiefly in the Transition Zone. The only specimens in the Museum of Vertebrate Zoology which are recorded as secured in midsummer were taken in the Transition Zone. Stephens reports securing specimens in San Diego County in spring and autumn only.

As noted above, a female taken near Pasadena May 29 contained a single embryo.

Myotis thysanodes Miller

Fringed Bat

Vespertilio albescens velifer (variety), H. Allen (1894, pp. 92–93). Dulzura (see Miller, 1897*b*, p. 80).

Vespertilio albescens evotis, H. Allen (1894, p. 90), part. Old Fort Tejon (see Miller, 1897*b*, p. 80).

Myotis thysanodes Miller (1897*b*, pp. 80–85). Original description; type locality, Fort Tejon.

Myotis evotis thysanodes, Elliot (1901, p. 406). Diagnosis; distribution.

Myotis thysanodes, Miller and Rehn (1901, p. 258). Type locality.

Myotis thysanodes, Elliot (1904*b*, pp. 572–573). Diagnosis; distribution.

Myotis thysanodes, Elliot (1905, p. 479). Distribution.

Myotis thysanodes, Stephens (1906, p. 268). Description; distribution.

Myotis thysanodes, Lyon and Osgood (1909, p. 273). Nature and location of type.

Myotis thysanodes, Miller (1912, p. 59). General range.

Myotis thysanodes, J. Grinnell (1913*b*, pp. 278–279). Range in California.

Diagnosis.—Total length, 85 to 95 millimeters. Free border of uropatagium thickened and densely haired.

Description.—Largest *Myotis* found in California excepting *Myotis velifer*. Easily distinguished from *velifer* by the much longer ears which, when laid forward, reach from 3 to 5 millimeters beyond end of nose. In an alcoholic specimen the ear measures 15 millimeters from notch and the tragus 10 millimeters. Ear convex in outline along anterior edge, bluntly rounded at tip and concave along upper half of posterior margin, thence convex to the well-defined basal notch. Tragus slender and straight, or nearly straight, along anterior edge almost to tip, but convex just below bluntly rounded tip; posterior border slightly concave just below tip, then convex; margin notched just above the basal lobe.

Limbs and Membranes.—Wing membranes similar to those of closely related species of *Myotis*, but interfemoral membrane heavier and more leathery, and distinctly thickened on its free edge. Wings arise just proximal to bases of toes. Calcar distinct and slightly lobed at tip. Foot slightly less than half length of tibia. Forearm slightly longer than tail.

Pelage.—Except for thickly haired border of uropatagium distribution of fur is similar to that of related species.

Color.—As all the adult examples at hand are alcoholic the following color description is taken from Miller (1897*b*, p. 81):

> The fur is everywhere light, dull, yellowish brown, distinctly paler ventrally, the hairs everywhere dusky slate at base. The color is subject to considerable individual variation in shade. The palest specimens are yellowish wood brown inclining to clay color; the darkest specimens dull raw umber. The belly varies from clear gray scarcely tinged with yellow to a strong yellowish gray, and in other specimens to dull brownish gray. The exact shades are very variable and impossible to describe accurately.

Skull.—About 16 millimeters long, thus about equal to that of *Myotis velifer* in total length, but quite distinct in general appearance (pl. 21, fig. 35, and pl. 22, fig. 47). Rostral portion of skull relatively slender (the diameter of rostrum, taken just posterior to the canines, averaging a millimeter less in *thysanodes* than in *velifer*). Sagittal crest well-defined in *velifer*, but indistinct in *thysanodes*. As pointed out by Miller (1897*b*, p. 82) the posterior margin of the brain-case, when viewed from above, is rounded in *thysanodes*, squarish, or truncate, in *velifer*.

Measurements.—Miller (1897*b*, p. 83) gives the average measurements of a series of ten specimens of *Myotis thysanodes* from Fort Tejon as follows: Total length, 87.0 millimeters; tail vertebrae, 37.0; tibia, 17.6; foot, 8.0; forearm, 41.2; thumb, 6.3; longest finger, 69.2; ear from meatus, 17.6; width of ear, 11.8; tragus, 10.5.

Synonymy and History.—This bat was described by Miller (1897*b*, pp. 80–85) under the name *Myotis thysanodes*. The type specimen was obtained at Fort Tejon. Miller states that specimens of the fringed bat were variously labeled or listed in his monographs by H. Allen as "*V[espertilio]. albescens velifer,*" "*V. subulatus,*" "*V. albescens?,*" and "*V. albescens evotis.*"

Distribution.—Given by Miller (1912, p. 59) as the Lower Sonoran zone from near the southern border of the United States south to San Luis Potosi and Michoacan, Mexico. The only Californian localities of capture known to the writer besides those given by Miller (Fort Tejon, Kern County, and Dulzura, San Diego County), are Limekiln and Fyffe, Eldorado County. These four localities are all but one well within the Upper Sonoran life-zone; Fyffe is in Transition. (See map, text-fig. N.)

Specimens Examined.—Total number, 7, from the following localities in California: Kern County: Fort Tejon, 5 alcoholics (U. S. Biol. Surv.); Eldorado County: Limekiln, 1 (no. 24206, Mus. Vert. Zool., August 2, 1916); Fyffe, 1 (no. 24186, Mus. Vert. Zool., July 21, 1916).

Natural History.—Miller (1897*b*, pp. 84–85) gives the following account, furnished by Dr. T. S. Palmer, of the colony of bats from which the type specimen of *Myotis thysanodes* was taken:

In July, 1891, while one of the parties of the Death Valley Expedition was collecting at Old Fort Tejon, California, several species of bats were observed. The most abundant was a small *Vespertilio* [=*Myotis*], which could be seen at dusk flying about the oak trees near the old barracks in great numbers, and passing in and out of the ruined buildings. A long two-story adobe building, with the roof still intact, seemed to be the center of attraction, and about sundown bats could be seen streaming forth from a window in one of the gables. On the morning of July 5 an examination was made of the attic of this building, and the bats were found clinging to the ridgepole and the rafters, literally by thousands. Individuals of all ages, from recently born young to adults, were hanging together in bunches as big as a bushel basket. Others found concealment in cracks and crevices, but very few were flying about. Evidently the colony had occupied the attic for several years, but it was too dark to see whether more than one species was present.

A sack was carried along under the ridgepole and specimens swept into it from several of the larger bunches. In this way more than a hundred bats were collected in a few minutes. As soon as they were disturbed they uttered a peculiar squeaking note and flew about in a confused manner in their efforts to escape. The sack was carried out under one of the oak trees and the specimens examined; 160 had been captured, and of these 25 were preserved[1] and the remainder allowed to escape. Some of the bats which had been given their liberty attempted to fly back to their retreat, but dazed by the sunlight took refuge in the branches of the nearest tree; others made no attempt to escape, except to crawl up the trunks of the trees, where they remained until dark. Some of the young ones failed to find their way back to the building, and remained about the spot for several days.

In the summer of 1904 (July 19 to 26) J. Grinnell visited Fort Tejon and collected bats in the same locality visited by Dr. Palmer in 1891. Of the sixty-one examples of *Myotis* obtained on the later date not one proved to be *Myotis thysanodes.*

Apparently bats of this species are not of wide distribution in California, for among nearly a thousand specimens of bats collected by the Museum of Vertebrate Zoology, only two have proven to be *Myotis thysanodes.*

Genus **Lasionycteris** Peters

This genus includes the type species only, which is distributed clear across northern North America and south nearly through the United States.

Characters.—Dental formula: $i\,\frac{2-2}{3-3},\ c\,\frac{1-1}{1-1},\ pm\,\frac{2-2}{3-3},\ m\,\frac{3-3}{3-3}=36.$ Upper incisors conical; inner upper incisor slightly the longer, and bicuspidate. Lower incisors subequal and crowded closely between canines; crowns of inner lower incisors four-lobed, those of the outer lower incisors three-lobed. Canines both above and below

[1] Sixteen proved to be *Myotis thysanodes;* the others were *M. yumanensis.*

simple, each with a distinct but rather small cingulum. First upper premolar minute; second slightly more than half height of canine. First two lower premolars minute, being less than half the height of the third.

Skull (pl. 21, fig. 33, and pl. 22, fig. 45) broad and somewhat flattened; rostrum three-fourths width of brain-case, and strongly concave on each side back of nasal aperture.

Ear short, nearly as broad as long, and with a well-developed basal lobe. Tragus short, straight, and bluntly rounded.

Lasionycteris noctivagans (Le Conte)

Silvery-haired Bat

V[espertilio]. noctivagans Le Conte (1831, p. 431). Original description; no type locality designated.

Scotophilus noctivagans, H. Allen (1864, pp. 39–42, four figs. in text). Description; listed from Fort Reading (in Shasta County).

Scotophilus noctivagans, Cooper (1868, p. 5). Distribution.

S[cotophilus]. noctivagans, Cooper (*in* Cronise, 1868, p. 442). Occurrence in California.

Vesperugo noctivagans, Dobson (1878, pp. 238–239). Description; general distribution (includes California).

Vesperugo noctivagans, C. H. Townsend (1887, p. 182). Record of specimen secured at Fort Reading by Dr. J. F. Hammond.

Vesperugo noctivagans, Bryant (1891*a*, p. 358). Nominal.

Lasionycteris noctivagans, H. Allen (1894, pp. 105–111, pls. 13–14). Description.

Lasionycteris noctivagans, Miller (1897*b*, pp. 86–87). Description; distribution; listed from Nevada City and Nicasio.

Lasionycteris noctivagans, Elliot (1901, pp. 407–408, fig. 85). Diagnosis; distribution.

Lasionycteris noctivagans, Stone (1904*a*, p. 579). Summer record from Mt. Sanhedrin.

Lasionycteris noctivagans, Stephens (1906, pp. 268–269). Description; distribution.

Lasionycteris noctivagans, Seton (1909, p. 1168). Map showing record stations and hypothetical range.

Lasionycteris noctivagans, Miller (1912, p. 60). General range.

Lasionycteris noctivagans, J. Grinnell (1913*b*, p. 279). Range in California.

Diagnosis.—Total length 92 to 107 millimeters; ears short and rounded; color blackish chocolate, both above and below, many of the hairs tipped with silvery white.

Description: Head.—Rostrum broad, two-thirds width of braincase; width between nostrils greater than distance from mouth to top of rostrum; prominent glandular masses on each side of rostrum. Ear short (height from meatus, 15 to 16 millimeters) and broad (width, 11 to 14 millimeters); when laid forward reaching barely to nostrils. Tragus a little less than half height of ear.

Limbs and Membranes.—Wings moderately slender; third metacarpal slightly longer than fifth. Wing membranes attached to bases of toes. Interfemoral membrane reaching to tip of tail. Foot slender, somewhat compressed, and about half length of tibia. Calcar distinct and extending along edge of interfemoral membrane for about a quarter of the distance from its origin to tip of tail.

Pelage.—Face nearly naked save for about a dozen slender hairs, 5 millimeters in length, which arise from the glandular masses on sides of rostrum. Hair on top of head short, being only about 2 millimeters in length; elsewhere on the body it is from 5 to 8 millimeters in length and very silky in texture. Ears naked, as also the wings, save for a narrow strip of hair continuous with body fur. Interfemoral membrane scantily haired over proximal half of its dorsal surface; upon its ventral surface the hairs are even less plentiful. Dorsal surface of toes well furred.

Color.—The fur varies from deep blackish chocolate, tipped with silvery white, to a decided brownish, tipped with yellowish gray. Seton (1909, p. 1167) states that he has in his collection an old female silvery-haired bat, taken in New York State, which is brownish black everywhere, with no trace of the silver tippings. A male in the Museum of Vertebrate Zoology (no. 13802), taken August 4, 1911, on Kangaroo Creek, Siskiyou County, California, has the membranes and the basal part of the fur everywhere blackish. On the back, belly, and interfemoral membrane the hairs are tipped with silvery white. On the face, crown, throat, and a patch over each shoulder the silvery tips are lacking. This specimen, as evidenced by the thin, papery skull and the prominent joints of the fingers, is a juvenal. Merriam (1884, p. 191) states that the young alone possess the perfect silvery tips to the hairs and that even before going into winter quarters for the first time their pelage has assumed the grizzled appearance which characterizes the coats of the adults.

Skull and Teeth.—The skull and teeth have been sufficiently described under the characterization of the genus (see p. 299).

Average Measurements.—A series of 12 specimens of the silvery-haired bat, including both sexes, averages in millimeters as follows: total length, 102.0 (extremes, 92.0–107.0); tail vertebrae, 41.1 (34.0–44.0); tibia, 15.8 (14.0–18.0); foot, 10.0 (9.5–10.0); forearm, 39.2 (37.3–42.0); greatest length of cranium, 16.1 (15.5–16.5).

Synonymy and History.—The silvery-haired bat was first described by Le Conte (1831, p. 31) from a specimen from the "Eastern United States" under the name *V[espertilio]. noctivagans.* Peters (1865, p. 648) made this bat the type species of his new genus *Lasionycteris.*

Distribution.—Miller (1912, p. 60) gives the general range of *Lasionycteris noctivagans* as "North America north of Mexico, from the Atlantic to the Pacific; probably not breeding south of the Transition Zone." The range in California lies altogether within the northwestern portion of the state, and for the most part within the Transition Zone. (See map, text-fig. O.)

Measurements in Millimeters of Twelve Specimens of Lasionycteris noctivagans (LeConte), from California

Mus. no.	Sex	Total length	Tail vertebrae	Tibia	Foot	Forearm	Greatest length of cranium	Zygomatic breadth	Breadth of brain-case	Interorbital constriction
3281[1]	♂	102.0	41.0	17.0	10.0	39.0	......	....	....	....
3282[1]	♂	99.0	38.0	17.0	10.0	42.0	......	....	....	....
18493[2]	♂?	92.0	37.0	......	9.5	38.5	15.5	9.3	....	4.0
3279[3]	♀	98.0	41.0	15.0	10.0	40.0	......	....	....	....
3280[3]	♀	106.0	42.0	18.0	10.0	39.0	16.4	....	8.5	4.3
24208[4]	♀	104.0	41.0	......	8.0	39.0	16.2	9.5	7.9	4.2
24212[4]	♀	106.0	42.0	15.8	9.0	40.0	16.3	....	8.0	4.2
24210[4]	♀	....	44.0	16.0	9.0	......	16.2	....	7.9	4.1
24211[4]	♀	107.0	42.0	14.3	9.0	37.3	......	9.8	8.0	4.1
24207[4]	♀	105.0	42.0	14.7	8.0	39.7	16.5	9.9	8.0	4.2
24209[4]	♀	98.0	40.0	......	8.0	38.4	16.2	9.7	8.0	4.3
24213[4]	♀	105.0	44.0	15.0	9.0	38.3	16.1	....	7.9	4.4

[1] From 7000 ft., Mt. Shasta, Siskiyou County.
[2] From 4 miles north of Oroville, Butte County.
[3] From McCloud River, near Baird Station, Shasta County.
[4] From Fyffe, 3700 ft. alt., Eldorado County.

Specimens Examined.—The writer has examined 40 specimens of the silvery-haired bat, from the following localities in California: Siskiyou County: Kangaroo Creek, 2; Mt. Shasta (at 7000 feet altitude), 2; Shasta County: McCloud River, 15 miles east of Baird Station, 2; 13 miles east of Baird Station, 2 (Univ. Calif. Dept. Zool.); near Baird Station, 1; Humboldt County: Redwood Creek, 1 (U. S. Nation. Mus.); Trinity County: Cañon Creek, 2 (U. S. Biol. Surv.); Butte County: 4 miles north of Oroville, 1; Mendocino County: Mt. Sanhedrin, 5 (Acad. Nat. Sci. Phila.); Nevada County: Nevada City, 1 (U. S. Biol. Surv.); Eldorado County: Fyffe, 11; Bijou, 1 (Acad. Nat. Sci. Phila.); Marin County: Olema, 1 (Calif. Acad. Sci.); Nicasio, 6 (Amer. Mus. Nat. Hist., 3; U. S. Nation. Mus., 3); Monterey County: Pacific Grove, 1 (U. S. Biol. Surv.).

Natural History.—The most extended account of the habits of the silvery-haired bat is that of Merriam (1884, p. 190). His observations were made in the Adirondack region of New York. Here he found the bats showing when abroad in the evening a decided liking for waterways, in some places keeping directly over the water. Several bats which were shot and fell into the water swam swiftly and powerfully through the strong current to the shore, fifteen or twenty feet distant. A scarcely less favored haunt was the edges of hardwood groves, where the bats darted in and out among the branches in search of insects.

The flight of this species is described by Merriam as neither so rapid nor so irregular as that of the red or of the hoary bat.

In the region where Merriam made his observations the young were born early in July, and were either one or two in number.

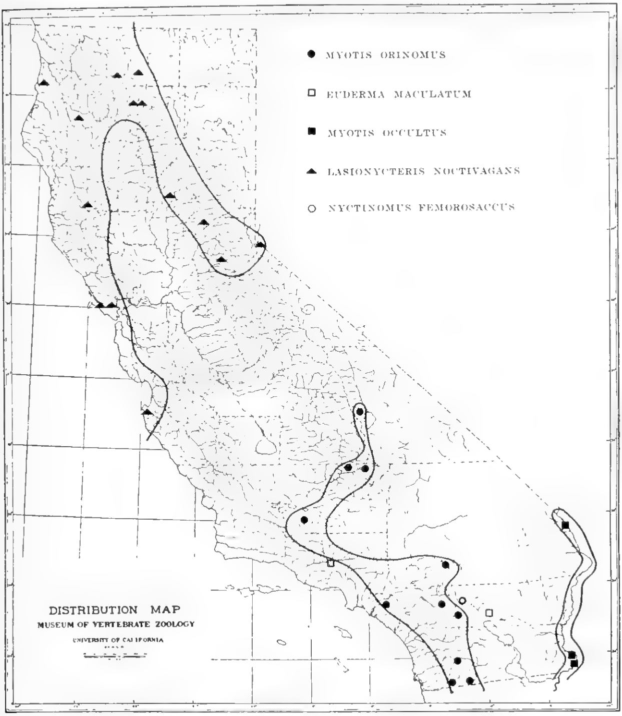

Fig. O. Map showing stations of occurrence in California of *Myotis orinomus*, *Euderma maculatum*, *Myotis occultus*, *Lasionycteris noctivagans*, and *Nyctinomus femorosaccus*, as established by specimens examined by the author.

In California the writer is aware only of summer and fall records of this bat. The earliest capture is of a female (no. 159941, U. S. Biol. Surv.), at Pacific Grove, May 25; the latest, of a male (no. $\frac{1103}{532}$, Amer. Mus. Nat. Hist.), at Nicasio, October 19. The species is known to be migratory in at least the eastern portion of its range, and the same probably holds true here in California. The known facts relating to its migration are recorded on page 232 of the present paper.

Of nine specimens obtained by Joseph Dixon at Fyffe (3700 feet altitude), Eldorado County, between July 19 and 31, seven were adult females weighing from 10.2 grams to 12.1 grams each, one was an immature female weighing 6.3 grams, and one a male, probably immature, weighing 8.5 grams. Some of the adult females showed evidences of having recently nursed young.

Genus **Pipistrellus** Kaup

This genus ranges in the Eastern Hemisphere from the northern to the southern limits of tree growth, and from Tasmania to Ireland. In the Western Hemisphere it occurs from the northern United States (except in the Boreal zone) to southern Mexico (Barrett-Hamilton, 1910, p. 102). The genus contains about forty species, only one of which occurs in the area under consideration, where it is represented by two subspecies.

Characters.—Dental formula: $i\,\frac{2-2}{3-3}$, $c\,\frac{1-1}{1-1}$, $pm\,\frac{2-2}{2-2}$, $m\,\frac{3-3}{3-3} = 34$. Upper inner incisor about one-third higher than outer one. Lower incisors all of about equal size and with columnar shafts, separated from each other by spaces about one-third the width of the shaft; the abruptly wider crowns are imbricated and deeply trilobed. Upper canine conical and about twice height of lower canine, which is similar in form but with a more highly developed cingulum. First upper premolar minute and lying on inner side of tooth row, crowded in angle between canine and second upper premolar. Second upper premolar about midway in height between canine and first molar. First lower premolar about half height of second and closely crowded against cingulum of canine; cingulum of this premolar about equal in width to that of canine. Second lower premolar nearly equal in height to lower canine. Molar teeth normal for vespertilionid bats.

Greatest width of skull about two-thirds of the total length of same. Brain-case distinctly flattened above and forming only a slight angle with rostrum. Auditory bullae large, their greatest diameter being distinctly greater than the width of the space between them. Zygomata slightly expanded. (See pl. 21, fig. 27, and pl. 22, fig. 39.)

Ear in this genus distinctly longer than broad and tapering to a narrowly rounded tip. Tragus broadest below its center, its tip straight or slightly curved forwards. Dorsal surface of interfemoral membrane sprinkled with hairs on basal third. Mammae two.

Pipistrellus hesperus hesperus (H. Allen)

Western Bat

Scotophilus hesperus H. Allen (1864, pp. 43–44, figs. 38–40), part. Original description; type locality, Fort Yuma, California [first locality mentioned in list of specimens].

Scotophilus hesperus, Cooper (1868, p. 5), part. Distribution.

S[cotophilus]. hesperus, Cooper (*in* Cronise, 1868, p. 442). Nominal.

Vespertilio (Vesperugo) hesperus, Coues and Yarrow (1875, pp. 94–95). Diagnosis; distribution.

Vesperugo hesperus, True (1887, p. 515). Concerning the status of *V. hesperus* and of *V. merriami.*

Vesperugo hesperus, Bryant (1891*a*, p. 358). Nominal.

Vesperugo hesperus, H. Allen (1894, pp. 128–131, pls. 20–21). Description; distribution.

Pipistrellus hesperus, Miller (1897*b*, pp. 88–90, figs. 20–23), part. Description; distribution.

Pipistrellus hesperus, Elliot (1901, pp. 408–409, fig. 86), part. Diagnosis; distribution.

Pipistrellus hesperus, Miller and Rehn (1901, p. 259). Type locality.

Pipistrellus hesperus, Elliot (1904*a*, p. 320), part. Localities of capture in California.

Pipistrellus hesperus, Elliot (1904*b*, pp. 582–583, figs. 86, 108), part. Diagnosis; distribution.

Pipistrellus hesperus, Elliot (1905, pp. 480–481), part. Geographical distribution.

Pipistrellus hesperus, Stephens (1906, pp. 269–270), part. Description; distribution; habits.

Pipistrellus hesperus, Elliot (1907, pp. 507–508), part. Localities of capture in California.

Pipistrellus hesperus; J. Grinnell (1908, pp. 159–160). Distribution and habits in the San Bernardino Mountains.

Pipistrellus hesperus, Lyon and Osgood (1909, p. 274). Nature and location of type.

Pipistrellus hesperus, Miller (1912, p. 60), part. General range.

Pipistrellus hesperus hesperus, J. Grinnell (1913*b*, p. 279), part. Range in California.

Pipistrellus hesperus hesperus, J. Grinnell (1914, pp. 267–268). Occurrence on the Colorado River; habits; status of subspecies.

Diagnosis.—Size very small (total length, 62 to 80 millimeters; forearm, 26.6 to 30.7 millimeters); tragus blunt, with tip bent forward; general color of fur buffy gray above, whitish beneath; membranes, ears, and feet, blackish.

Description: Head.—Muzzle short and broad, the greatest width of the rostrum equaling its length. Nostrils circular and directed outward and downward; region between them slightly concave. Eye small, inconspicuous and situated above and posterior to angle of mouth. A glandular swelling on each side of head between nostril and eye. Ear short, in an alcoholic specimen reaching only to a point midway between eye and nostril, when laid forward; anterior border of auricle strongly convex from the well developed basal notch to about middle, where it becomes straight and continues so almost to the broadly rounded tip; posterior border concave immediately below tip, then strongly convex to basal notch; basal lobe well developed, separated from main auricle by a deep notch, and joining face at a point slightly below and behind angle of mouth. Tragus less than half height of ear, slightly blunt at tip, and curved forward (text-fig. L). The western bat and the Merriam bat are the only small bats of California having the tragus curved, and this feature is sufficient to distinguish them at once from the several small species of *Myotis*.

Limbs and Membranes.—Wing short and broad, length of fifth metacarpal almost equaling that of third. Wing membrane attached at base of outer toe. Calcar very slightly lobed at tip. Tip of tail projecting somewhat beyond edge of interfemoral membrane. Foot small, tibia short; length of former scarcely less than half that of latter. Tail about equal in length to forearm.

Pelage.—Fur everywhere full and soft, 3 to 4 millimeters in length on body. Dorsal surface of ear furred only on its basal third; a scanty sprinkling of fine hairs over whole ventral (inner) surface of ear. Wing membranes naked both above and below, save for a very narrow strip of fur, about one millimeter in width, which extends out from side of body. Basal third of interfemoral membrane sprinkled with fine hairs, both above and below. Toes scantily clothed, both above and below, with very short, fine hairs.

Color.—Hairs everywhere plumbeous-black at bases. Distal two-thirds of fur on upper surface light buff, brightest on top of head; on lower surface a very pale tint of light buff, almost white; pelage everywhere given a grayish cast by the showing through of the darker bases of the hairs. Ear, muzzle, and wing and tail membranes, blackish, save that wing membrane is narrowly bordered with pale gray between foot and fifth finger.

Skull.—Form and general characteristics as for the genus. In general, as has been suggested, the skull of this bat reminds one of a miniature *Lasionycteris*.

Measurements.—Average and extreme measurements in millimeters of a series of twenty western bats, from the Colorado River Valley, are as follows: ten males: total length, 66.4 (extremes, 62.0–72.0); tail vertebrae, 26.5 (24.0–30.0); tibia, 10.6 (10.0–11.5); foot, 5.0; forearm, 27.8 (26.6–30.0); greatest length of cranium, 11.5 (11.3–11.9). Ten females: total length, 72.9 (69.0–80.0); tail vertebrae, 29.9 (26.0–33.0); tibia, 11.2 (10.0–12.0); foot, 5.2 (5.0–6.0); forearm, 29.8 (27.3–30.7); greatest length of cranium, 11.9 (11.7–12.3).

A comparison of the above averages will show that the females are as a rule somewhat larger than the males.

Synonymy and History.—The western bat was described by H. Allen (1864, pp. 43–44) under the name *Scotophilus hesperus* from material obtained at Fort Yuma, California, and "Posa Creek." According to True (1887, p. 515), Dobson in his catalogue of the

MEASUREMENTS IN MILLIMETERS OF TWENTY ADULT SPECIMENS OF PIPISTRELLUS HESPERUS HESPERUS (H. ALLEN), FROM CALIFORNIA

Mus. no.	Sex	Locality	Total length	Tail vertebrae	Tibia	Foot	Forearm	Greatest length of cranium	Zygomatic breadth	Breadth of brain-case	Interorbital constriction
10386	♂	Opposite The Needles, Colorado River	66.0	27.0	10.3	5.0	27.4	11.3	7.4	6.0	3.0
10388	♂	Opposite The Needles, Colorado River	65.0	26.0	10.8	5.0	26.8	11.5	7.0	5.7	3.0
10389	♂	Opposite The Needles, Colorado River	65.0	26.0	10.0	5.0	26.8	11.4	7.4	6.0	3.1
10390	♂	Opposite The Needles, Colorado River	67.0	27.0	10.0	5.0	28.0	11.3	7.0	5.8	3.0
10391	♂	Opposite The Needles, Colorado River	64.0	24.0	10.0	5.0	28.6	11.4	7.2	6.0	3.2
10392	♂	Opposite The Needles, Colorado River	67.0	27.0	11.0	5.0	26.6	11.4	6.9	5.9	3.0
10393	♂	Opposite The Needles, Colorado River	65.0	27.0	11.5	5.0	30.0	11.9	7.4	6.0	3.0
10397	♂	20 miles north of Picacho, Colorado River	62.0	24.0	11.0	5.0	27.4	11.4	7.2	6.2	3.0
10402	♂	Potholes, Colorado River	70.0	27.0	10.8	5.0	27.8	11.9	7.8	6.3	3.0
10403	♂	Potholes, Colorado River	72.0	30.0	10.7	5.0	28.8	11.9	7.4	6.2	3.3
10400	♀	8 miles east of Picacho, Colorado River	72.0	30.0	12.0	5.0	30.4	11.9	7.6	6.2	3.0
10401	♀	8 miles east of Picacho, Colorado River	80.0	33.0	12.0	6.0	30.4	12.2	7.7	6.4	3.2
10387	♀	Opposite The Needles, Colorado River	69.0	27.0	10.0	5.0	29.8	11.9	7.5	6.0	3.1
10396	♀	20 miles north of Picacho, Colorado River	73.0	30.0	11.5	5.0	30.4	11.7	7.8	6.3	3.0
10406	♀	Near Pilot Knob, Colorado River	71.0	26.0	11.0	5.0	27.3	12.3	7.6	6.4	3.2
10407	♀	Near Pilot Knob, Colorado River	71.0	30.0	10.8	5.0	27.5	11.7	7.5	6.3	3.2
10411	♀	Near Pilot Knob, Colorado River	71.0	31.0	11.0	5.0	30.0	11.9	7.5	6.3	3.0
6936	♀	Cushenbury Springs, San Bernardino Mts.	73.0	31.0	10.8	5.0	30.2	11.7	7.8	6.2	3.2
6680	♀	Cushenbury Springs, San Bernardino Mts.	76.0	29.0	11.5	5.0	30.7	12.2	7.8	6.4	3.4
17794	♀	Lone Pine Creek, Inyo Co.	73.0	32.0	11.4	6.0	30.0	12.3	7.5	6.4	3.3

Chiroptera regards *V. hesperus* as identical with *V. abramus*, an Old World species. Later, Dobson (1886, p. 124) described a new species of North American *Vesperugo* under the name of *V. merriami*, basing his description on a single specimen sent him by C. H. Merriam. Dobson gives the type locality as Locust Grove, New York, the home of Dr. Merriam. Miller (1897*b*, p. 31) points out the error and states that the specimen really came from Red Bluff, Tehama County, California, and places the name *merriami* in the synonymy of *hesperus*. J. Grinnell (1913*b*, pp. 279–280) revives the name *merriami* and applies it to the race of *hesperus* occupying the Lower and Upper Sonoran zones in California west of the desert divides, thus restricting the subspecific application of the name *hesperus* to the desert race.

Distribution.—Specimens available indicate that the range of *Pipistrellus h. hesperus* occupies the Lower Sonoran zone chiefly east of the Pacific divides, comprising the Colorado and Mohave deserts, and extends from the Mexican line north at least to Coleville, Mono County (see map, text-fig. P). J. Grinnell (1913*b*, p. 279) gives the range of this bat as extending west to Fort Tejon, Kern County; but the present writer finds upon examination of the specimens upon which this record was based that while Tejon specimens are not typical *merriami* they bear a closer resemblance to that form than to *Pipistrellus h. hesperus.*

Specimens Examined.—The writer has examined 157 specimens of *Pipistrellus hesperus hesperus*, from the following localities in California: Imperial County: Colorado River near Pilot Knob, 18; Potholes, 4; four miles south of Potholes, 1; eight miles east of Picacho, 7; twenty miles above Picacho, 7; Thermal, 2; San Diego County: Carrizo Creek, 3; Santa Ysabel, 14 (U. S. Nat. Mus.); Jacumba, 2 (U. S. Nat. Mus.); Vallecito, 4; Dulzura, 6 (Amer. Mus. Nat. Hist.); Palmetto Spring, 3; Riverside County: Dos Palmos Spring, Santa Rosa Mountains, 5; Cabezon, 1; Banning, 1; Palm Springs, 4 (U. S. Biol. Surv., 3; Mus. Vert. Zool., 1); Palm Cañon, 3; San Bernardino County: Borax Flat, 3 (U. S. Biol. Surv.); Needles, 4 (U. S. Biol. Surv.); Colorado River opposite The Needles, 13; east base Turtle Mountains, 1; Barstow, 1; Victorville, 1; Warren's Ranch, 1 (U. S. Biol. Surv.); Cushenbury Springs, 5; Kern County: west slope Walker Pass, 3; Weldon, 1; Onyx, 3; Fay Creek, 3; South Fork Kern River, 3 (U. S. Biol. Surv.); Kern River, 12 miles below Bodfish, 1; Inyo County: Lone Pine, 4 (Mus. Comp. Zool., 1; U. S. Biol. Surv., 3); Lone Pine Creek, 5; Independence, 1 (U. S. Biol.

Surv.); Death Valley, 4 (U. S. Biol. Surv.); Saline Valley, 1 (U. S. Biol. Surv.); Panamint Valley, 6 (U. S. Biol. Surv.); Panamint Mountains, 5 (U. S. Biol. Surv.); Funeral Mountains, 1 (U. S. Biol. Surv.); Mono County: Coleville, 2 (Mus. Comp. Zool.).

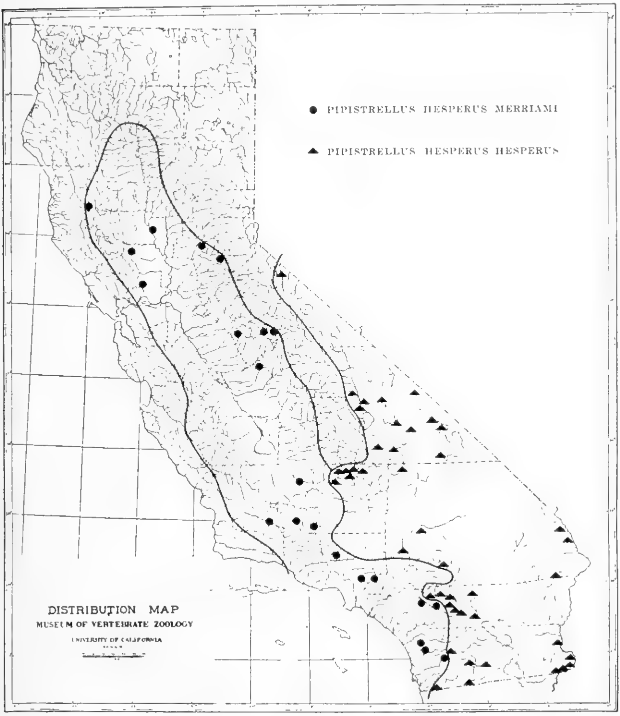

Fig. P. Map showing stations of occurrence in California of *Pipistrellus hesperus hesperus* and *Pipistrellus hesperus merriami*, as established by specimens examined by the author.

Natural History.—Stephens (1906, p. 270) records these bats as appearing early in the evening, sometimes soon after sunset, but states that because of their swift and erratic flight they are difficult to secure by shooting.

At Cushenbury Springs, on the desert slope of the San Bernardino Mountains, J. Grinnell (1908, pp. 159–160) found these bats common in the early part of August. They appeared at late dusk among the cottonwoods and over the pasture, and swarms of them were to be seen darting about over the surface of a small pond, frequently dipping down and touching the surface of the water as if drinking. The five specimens secured at that time and place were very fat.

In 1908, Grinnell and Swarth (1913, p. 382) found these bats abundant along Palm Cañon and in the neighborhood of Dos Palmos Spring, on the desert slope of the San Jacinto Mountains. Here they were found emerging from the crevices of rocks at early dusk. This was the only species of bat seen abroad after sunrise and before sunset; in fact one individual was seen in flight about 9 A.M. in the bright glare of the forenoon sun.

In the spring of 1910 J. Grinnell (1914, pp. 267–268) found the western bat abundant along the Colorado River between Needles and Pilot Knob. Here it was noticed that the bats were to be found only in the neighborhood of cliffs and rocky hillsides.

No instances of the occurrence of this bat in or about buildings or as hanging up on the foliage of trees, have been recorded.

Specimens in the Museum of Vertebrate Zoology have been taken in all the months from February to August, inclusive, and there is also a specimen taken at Palm Springs in December. Winter collecting would probably reveal the presence of this species throughout the year in at least the lowest parts of its range. Stephens (1906, pp. 269–270) states that very few western bats remain in California in winter. "The northward migration is at its height about the end of March, at which time" the bats are abundant about certain springs along the western border of the Colorado Desert.

The number of young and time of breeding are indicated by the following data, taken from specimens in the Museum of Vertebrate Zoology secured in Kern County in the summer of 1911: no. 16308, taken June 18, contained two embryos; no. 16309, taken June 19, contained two embryos; no. 16310, taken June 20, contained two embryos; no. 16312, taken June 23, contained two embryos; no. 16313, taken July 1, contained two embryos; no. 16314, taken July 11, contained one embryo.

Pipistrellus hesperus merriami (Dobson)

Merriam Bat

Scotophilus hesperus H. Allen (1864, pp. 43–44, figs. 38–40), part. Original description of *hesperus;* Posa Creek [Kern County] specimens referable to *merriami.*

Scotophilus hesperus, Cooper (1868, p. 5), part. Distribution.

Vesperugo merriami Dobson (1886, p. 124). Original description; type stated to be from Locust Grove, New York, but really from Red Bluff, Tehama County, California.

Vesperugo merriami, True (1887, p. 515). Validity doubted.

Vesperugo merriami, Bryant (1892, p. 223). Nominal.

Vesperugo merriami, Miller (1897*b*, p. 31). Nomenclature.

Pipistrellus hesperus, Miller (1897*b*, pp. 88–90), part. Description; general distribution.

Pipistrellus hesperus, Elliot (1901, pp. 408–409, fig. 86), part. Diagnosis; general distribution.

Pipistrellus hesperus, Elliot (1904*b*, pp. 582–583, figs. 108, 86), part. Diagnosis; general distribution.

Pipistrellus hesperus, Stone (1904*a*, p. 579). Record of occurrence in Mendocino County.

Pipistrellus hesperus, Elliot (1905, pp. 480–481), part. General distribution.

Pipistrellus hesperus, Stephens (1906, pp. 269–270), part. Description; distribution; habits.

Pipistrellus hesperus, Elliot (1907, pp. 507–508), part. Localities of capture in California.

Pipistrellus hesperus, Miller (1912, p. 60), part. General range.

Pipistrellus hesperus merriami, J. Grinnell (1913*b*, pp. 279–280). Range in California.

Pipistrellus hesperus merriami, J. Grinnell (1914, pp. 267–268). Status and range.

Diagnosis.—Size very small (total length 66 to 78 millimeters, forearm 27.5 to 30.8); tragus blunt, with tip bent forward; general color of fur buffy brown both above and below; membranes, ears, and feet, blackish.

Description.—This subspecies, *Pipistrellus hesperus merriami,* very closely resembles the preceding one, *Pipistrellus hesperus hesperus,* differing only in darker coloration and in slightly larger average size.

Color.—Wing and tail membranes, ears and feet, blackish (see pl. 18, fig. 16). Terminal portion of body fur, both above and beneath, nearest "warm buff" of Ridgway's *Color Standards;* but the darker bases of the hairs showing through lend a brownish aspect to the mass appearance.

Measurements.—Average and extreme measurements in millimeters of a series of 16 specimens of the Merriam bat in the Museum of Vertebrate Zoology are as follows: six males: total length, 69.0 (extremes, 66.0–73.0); tail vertebrae, 29.0 (28.0–30.0); tibia, 11.0 (10.6–12.0); foot, 5.5 (5.0–6.5); forearm, 28.1 (27.5–29.0); greatest length of cranium, 11.6 (11.3–11.8); ten females: total length, 73.6 (67.0–78.0); tail vertebrae, 29.2 (26.0–34.0); tibia, 11.4 (11.1–11.7); foot, 5.6 (5.0–6.0); forearm, 29.6 (28.0–30.8); greatest length of cranium, 12.0 (11.9–12.2).

Synonymy and History.—The synonymy and history of this bat is included with that of *P. h. hesperus* on page 306. In his original description of *Pipistrellus hesperus,* H. Allen (1864, pp. 43–44) does not designate a type, but lists three specimens, the first being from Fort Yuma and the two remaining from Poso Creek (Kern County). Miller (1897*b*, p. 88) designates the Fort Yuma specimen (no. 5406 U. S. Nation. Mus.) as the type of *hesperus.* I have examined the two skins (nos. 5509 and 5570 U. S. Nation. Mus.) from Poso Creek and find them to be *Pipistrellus hesperus merriami,* as would be expected from the geographic position of this locality.

Distribution.—Specimens examined indicate the range of this bat as lying within the Upper Sonoran and Transition zones altogether west of the desert divides, from the Mexican line northwest through the San Diegan district and through the San Joaquin and Sacramento valleys, east of the humid coast belt and west of the Sierra Nevada, to Butte and Tehama counties (see map, text-fig. P). Specimens from Witch Creek (or Santa Ysabel), San Diego County, are allocated with difficulty, some appearing to be nearest *hesperus* and others nearest *merriami.*

Specimens Examined.—The writer has examined 46 specimens of *Pipistrellus h. merriami,* from the following localities in California: San Diego County: Twin Oaks, 2 (U. S. Biol. Surv.); Escondido, 1; Witch Creek, 4 (San Diego Soc. Nat. Hist., 1; U. S. Nation. Mus., 3); Riverside County: San Jacinto Mountains, 2 (U. S. Nation. Mus.); San Jacinto Lake, 5 (U. S. Nation. Mus.); Los Angeles County: Pasadena, 1; Rubio Wash, near Pasadena, 3; San Francisquito Cañon, 1; San Gabriel Cañon, 2 (U. S. Biol. Surv.); Kern County: Grapevine Cañon, near Fort Tejon, 3; San Emigdio, 1 (U. S. Biol. Surv.); Poso Creek, 2 (U. S. Nation. Mus.); San Luis Obispo County: Cuyama Valley, 1; Mariposa County: El Portal, 1; Pleasant Valley, 2; Yosemite Valley, 3; Madera County: Raymond, 3; Solano County: three miles west of Vacaville, 1; Yolo County: Rumsey, 3; Eldorado County: Limekiln, 2; Fyffe, 1; Sutter County: Butte Slough, 1; Mendocino County: Mt. Sanhedrin, 1 (Acad. Nat. Sci. Phila.).

Natural History.—The time of breeding and number of young is indicated by the following data, taken from specimens in the Museum of Vertebrate Zoology: female, no. 18497, taken near Vacaville, Solano

Measurements in Millimeters of Sixteen Adult Specimens of Pipistrellus hesperus merriami (Dobson), from California

Mus. no.	Sex	Locality	Total length	Tail vertebrae	Tibia	Foot	Forearm	Greatest length of cranium	Zygomatic breadth	Breadth of brain-case	Interorbital constriction
6937	♂	Rubio Wash, near Pasadena, Los Angeles Co.	73.0	28.0	12.0	6.0	28.8	11.8	7.7	6.3	3.3
5161	♂	Grapevine Cañon, near Ft. Tejon, Kern Co.	70.0	29.0	11.0	6.0	28.0	11.8	7.5	6.4	3.3
16669	♂	Cuyama Valley, San Luis Obispo Co.	67.0	30.0	10.6	5.0	27.5	......	....	....	....
14648	♂	Raymond, Madera Co.	67.0	28.0	10.7	5.0	28.0	11.8	7.3	6.3	3.2
14646	♂	Raymond, Madera Co.	66.0	29.0	11.0	5.0	27.7	11.3	6.8	6.0	3.0
18494	♂	Butte Slough, 1 mi. west Butte, Sutter Co.	71.0	30.0	......	6.5	29.0	......	....	....	....
6684	♀	San Francisquito Cañon, Los Angeles Co.	67.0	27.0	11.3	6.0	30.0	12.0	7.7	6.5	3.2
6681	♀	Grapevine Cañon, near Ft. Tejon, Kern Co.	78.0	30.0	11.2	6.0	......	......	....	....	....
6683	♀	Rubio Wash, nr. Pasadena, Los Angeles Co.	75.0	30.0	11.1	6.0	29.0	12.0	8.0	6.6	3.2
6682	♀	Pasadena, Los Angeles Co.	72.0	30.0	11.5	5.5	28.0	12.2	8.0	6.5	3.2
5162	♀	Rubio Wash, nr. Pasadena, Los Angeles Co.	75.0	31.0	11.7	5.+	30.6	......	7.8	....	3.5
5164	♀	Escondido, San Diego Co.	78.0	34.0	11.7	6.0	30.6	12.0	8.0	6.4	3.4
14647	♀	Raymond, Madera Co.	74.0	30.0	11.6	5.0	29.0	11.9	7.7	6.3	3.1
18497	♀	3 mi. west Vacaville, Solano Co.	73.0	26.0	......	6.0	30.0	12.0	7.5	6.3	3.2
18496	♀	Rumsey, Yolo Co.	75.0	27.0	......	6.0	30.8	12.2	8.0	6.6	3.5
18495	♀	Rumsey, Yolo Co.	69.0	27.0	......	5.0	28.8	11.9	7.8	6.4	3.4

County, July 2, 1912, two embryos; female, no. 18495; taken at Rumsey, Yolo County, June 24, 1912, two embryos. Two examples of the Merriam bat secured by Dixon at Limekiln, Eldorado County, August 2, 1916, weighed as follows: no. 24216, female, 4 grams; no. 24217, male, 3.5 grams.

Genus **Eptesicus** Rafinesque

According to Miller (1907, p. 208) this genus is represented in Africa, Madagascar, Australia, Asia (except the Malay region), and America from southern Canada southward (except the Lesser Antilles). About forty-five species belonging to this genus are known. In North America only one species, consisting of several races, is known to exist. Among the species of the Vespertilionine group occurring in California the one belonging to the genus *Eptesicus* may be readily distinguished by its comparatively large size (total length, 105 to 122 millimeters), reduced dental formula, and nearly uniform brown coloration of the body.

Characters.—Dental formula: i $\frac{2-2}{3-3}$, c $\frac{1-1}{1-1}$, pm $\frac{1-1}{2-2}$, m $\frac{3-3}{3-3} = 32$. Upper incisors both well developed, the outer one much the smaller, reaching barely to cingulum of inner one. Lower incisors almost uniform in size, forming a closely crowded convex row between the canines, with their crowns overlapping; the crowns tri-lobed, and that of the outermost slightly the largest. Canines, both above and below simple, each with distinct cingulum but no secondary cusp. Height of single upper premolar exceeds that of any molar. First lower premolar about half the size of the second.

Skull flattened above; angle between brain-case and rostrum slight; sagittal crest conspicuous. (See pl. 23, fig. 52; pl. 24, fig. 60).

Ears short (17 to 20 millimeters in height from meatus) and somewhat narrower than long; basal lobe well developed but not excessively large, being in length about half height of tragus. Tragus straight, short (7 to 9 millimeters in height), and directed slightly forward, broadest near middle, and tapering to a slightly blunted point. Membranes nearly naked. Mammae two.

Eptesicus fuscus (Peale and Beauvois)

Large Brown Bat

Vespertila fuscus Peale and Beauvois (1796, p. 14). Original description; type locality, Philadelphia.

Scotophilus fuscus, H. Allen (1864, pp. 31–35, figs. 27–29). Description; nomenclature; specimens listed from San Francisco and Posa Creek.

Scotophilus fuscus, Cooper (1868, p. 5). Distribution.

Scotophilus fuscus, Cooper (*in* Cronise, 1868, p. 442). Occurrence in California.

Vesperugo serotinus var. B, Dobson (1878, pp. 191–194). Description; specimen listed from Monterey.

Vesperugo serotinus, C. H. Townsend (1887, p. 182). Record of two specimens secured at northeast base of Mt. Shasta, Siskiyou County.

Adelonycteris fuscus, H. Allen (1894, pp. 112–121, pls. 15–17). Description; habits; specimens listed from Santa Barbara and San Francisco.

Vespertilio fuscus, Miller (1897*b*, pp. 96–99, figs. 24–26). Description; distribution; many California localities.

Vespertilio fuscus, Merriam (1899, p. 87). Occurrence on Mt. Shasta.

Vespertilio fuscus, Elliot (1901, p. 410). Diagnosis; distribution.

Eptesicus fuscus bernardinus Rhoads (1901, pp. 618–619). Original description of supposed new form from San Bernardino Valley; distribution.

Vespertilio fuscus bernardinus, Miller and Rehn (1903, p. 122). Type locality.

Vespertilio fuscus, Elliot (1904*a*, p. 320). Record stations in California.

Eptesicus fuscus bernardinus, Elliot (1904*b*, p. 589). Distribution; general characters.

Eptesicus fuscus, Stone (1904*a*, p. 579). Occurrence at Sanhedrin Mountain, Mendocino County.

Eptesicus fuscus melanopterus Rehn (*in* Stone, 1904*b*, pp. 590–591). Original description of supposed new form from Mt. Tallac, Eldorado County.

Vespertilio fuscus melanopterus, Elliot (1905, p. 483). Distribution; general characters.

Vespertilio fuscus bernardinus, Elliot (1905, p. 483). Distribution; general characters.

Eptesicus fuscus bernardinus, Stephens (1906, p. 270). Diagnosis; distribution.

Eptesicus fuscus melanopterus, Stephens (1906, pp. 270–271). Diagnosis; distribution.

Vespertilio fuscus, Elliot (1907, pp. 509–510). Localities of capture in California: Panamint Mountains; Fort Tejon; Mount Whitney.

Vespertilio fuscus, J. Grinnell (1908, p. 159). Occurrence in the San Bernardino Mountains.

Vespertilio fuscus bernardinus, J. Grinnell (1908, p. 159). Discussion of validity of subspecies.

Eptesicus fuscus, Seton (1909, p. 1179). Map showing actual record stations and hypothetical range.

[*Eptesicus fuscus*] *bernardinus*, Seton (1909, p. 1179). Map showing actual record stations and hypothetical range.

[*Eptesicus fuscus*] *melanopterus*, Seton (1909, p. 1179). Map showing actual record stations and hypothetical range.

Eptesicus fuscus melanopterus, Miller (1912, p. 62). Type locality.

Eptesicus fuscus bernardinus, Miller (1912, p. 62). Type locality.

Eptesicus fuscus fuscus, J. Grinnell (1913*b*, p. 280). Range in California.

Eptesicus fuscus fuscus, Grinnell and Swarth (1913, pp. 381–382). As occurring in the San Jacinto Mountains.

Eptesicus fuscus, J. Grinnell (1914, p. 268). As occurring along the Colorado River.

Diagnosis.—Size medium (total length 107 to 122 millimeters); ear about 18 millimeters in height, its width slightly less than two-thirds of height; tragus two-thirds height of ear, tapering, and directed slightly forwards. Color, varying dorsally from raw umber to vandyke brown, ventrally from pale wood brown to light bister.

Description: Head.—Muzzle short and broad, greatest width of rostrum almost equaling its length. Nostrils elliptical in shape and directed outward and slightly downward; region between them slightly concave. Eye small and inconspicuous and situated above posterior angle of mouth. A tumid, glandular area, some three or four millimeters in width, occupies entire space between nostril and eye on each side of head and adds to apparent width of rostrum. Ear short, reaching barely to nostril when laid forward. (See pl. 18, fig. 13.)

Limbs and Membranes.—Wing short and broad (text-fig. E), length of fifth metacarpal almost equaling that of third. Wing membrane attached to foot a little beyond bases of toes. Free edge of interfemoral membrane a little shorter than calcar and terminating at base of next to last caudal vertebra. Foot more than half length of tibia. Calcar slightly longer than foot, keeled on its outer edge, and terminating in a faintly defined lobe.

Pelage.—Fur everywhere full and soft; on dorsal surface of body about 7 millimeters in length, on ventral surface slightly shorter. Ears furred only on basal third of outer surface; scantily sprinkled with hairs over most of inner surface, these hairs being most numerous near anterior border of auricle. Dorsal surface of wing naked, save for narrow strip of fur continuous with fur of body. Ventral surface of wing membrane furred in a manner similar to that of dorsal surface. Interfemoral membrane furred only at its extreme base above; but below, scattering hairs extend almost to tip of tail. Toes scantily clothed, both above and below, with very fine, short hairs.

Color.—The color varies considerably, skins from even a single locality exhibiting a wide range. An average condition of coloration is shown by a brown bat taken at Kenworthy, in the San Jacinto Mountains, in May, 1908, as follows: above, bases of hairs dark seal brown, their distal two-thirds raw umber; hairs on throat pale wood brown; rest of fur on lower surface pale seal brown on basal half, the distal half pale wood brown. Ears and membranes blackish.

Skull and Teeth.—As described for the genus.

Measurements.—Average and extreme measurements in millimeters of a series of ten brown bats in the Museum of Vertebrate Zoology are as follows: five males: total length, 109.8 (extremes 107.0–112.0); tail vertebrae, 43.8 (38.0–47.0); tibia, 16.9 (16.0–17.5); foot, 9.0 (8.0–10.0); forearm, 44.1 (43.3–44.9); greatest length of cranium, 18.3 (17.9–18.8); five females: total length, 116.1 (110.0–119.0); tail vertebrae, 45.3 (43.0–48.0); tibia, 17.3 (16.4–18.0); foot, 10.0 (9.0–12.0); forearm, 46.2 (42.9–49.0); greatest length of skull, 19.0 (18.8–19.4).

A comparison of the above figures will show that the females average somewhat larger than the males.

MEASUREMENTS IN MILLIMETERS OF TWENTY-ONE ADULT EXAMPLES OF EPTESICUS FUSCUS (PEALE AND BEAUVOIS), FROM CALIFORNIA

Mus. no.	Sex	Locality	Total length	Tail vertebrae	Tibia	Foot	Forearm	Greatest length of cranium	Zygomatic breadth	Breadth of brain-case	Interorbital constriction
1864	♂	Kenworthy, San Jacinto Mts.	111.0	45.0	16.0	9.0	44.9	18.7	11.8	9.2	4.0
5173	♂	S. Fork Santa Ana River, San Bernardino Mts.	108.0	44.0	16.6	9.0	44.3	17.8	12.2	9.5	4.1
5177	♂	Cushenbury Springs, San Bernardino Mts.	111.0	38.0	17.0	8.0	43.3	18.4	12.0	9.4	4.4
5179	♂	Bluff Lake, San Bernardino Mts.	112.0	47.0	17.5	10.0	44.8	18.8	11.8	9.3	4.0
5176	♂	Bluff Lake, San Bernardino Mts.	107.0	45.0	16.6	9.0	43.3	18.0	12.0	9.4	4.2
5141	♂	Mt. Pinos, 6500 ft., Ventura Co.	110.0	46.0	18.5	9.0	44.7	18.5	12.4	9.4	4.4
20813	♂	1 mi. west Guerneville, Sonoma Co.	112.0	44.0	17.8	10.5	44.0	18.9	13.2	10.4	4.4
18499	♂	Rumsey, Yolo Co.	124.0	52.0	19.0	12.0	41.0	19.1	......	10.0	....
8904	♂	Sherwood, Mendocino Co.	112.0	45.0	.....	8.0	42.5	19.2	12.8	9.8	4.4
11840	♂	Eureka, Humboldt Co.	112.0	50.0	18.6	12.0	46.0	19.5	12.5	9.9	4.5
2246	♀	Hemet Lake, San Jacinto Mts.	119.0	48.0	17.0	12.0	46.5	19.0	12.7	10.0	4.6
6688	♀	Arroyo Seco, near Pasadena	110.0	43.0	16.4	9.0	42.9	19.0	11.9	9.5	4.3
6697	♀	Arroyo Seco, near Pasadena	118.0	45.0	17.3	10.0	47.0	18.8	12.7	10.0	4.1
6942	♀	Arroyo Seco, near Pasadena	116.0	47.0	18.0	9.0	46.0	19.4	13.0	10.1	4.5
5144	♀	Fort Tejon, Kern Co.	119.0	45.0	18.0	10.0	49.0	18.8	12.6	10.0	4.5
10697	♀	Pilot Knob, Colorado River	107.0	44.0	17.0	9.0	42.5	18.3	12.3	9.6	4.4
14649	♀	Raymond, Madera Co.	116.0	48.0	20.0	10.0	47.0	19.2	12.9	9.7	4.1
18498	♀	Mill Creek, 2 mi. N.E. Tehama, Tehama Co.	119.0	46.0	......	10.0	46.3	19.2	......	10.1	4.4
20814	♀	1 mi. west Guerneville, Sonoma Co.	120.0	49.0	19.0	10.5	46.2	19.8	13.2	10.2	4.5
11841	♀	Eureka, Humboldt Co.	122.0	53.0	18.0	12.0	46.7	20.4	13.8	10.2	4.7
11842	♀	Eureka, Humboldt Co.	120.0	49.0	18.5	12.0	47.0	20.0	13.0	10.2	4.6

Synonymy and History.—The brown bat was described by Peale and Beauvois (1796, p. 14) under the name *Vespertila* (perhaps misprint for *Vespertilio*) *fuscus* from material collected at Philadelphia, Pennsylvania.

Eptesicus fuscus bernardinus was described by Rhoads (1901, p. 619) from a single specimen taken near San Bernardino, California. This individual is described as "pallid bistre above, brownish drab below; . . . wing membranes and ears in *bernardinus* very dark."

Eptesicus fuscus melanopterus was described by Rehn (*in* Stone, 1904*b*, pp. 590–591) from five specimens obtained at Mount Tallac, Eldorado County, California. The color is given as "above rather dark cinnamon, lightest on the top of the head and at the shoulders. Under surface reddish wood brown. Membranes and face deep blackish."

As explained beyond, under General Remarks, the latter two names had best be kept in synonymy until better reasons have been brought forward than have so far been advanced for the recognition of more than one subspecies within the state.

Distribution.—The range of this species extends over the whole of the United States and into British Columbia (Miller, 1897*b*, p. 96). In California it occurs chiefly in the Upper Sonoran and Transition zones, where it has been found practically throughout the state. (See map, text-fig. Q.).

Specimens Examined.—The writer has examined 278 specimens of the large brown bat from the following localities in California: Siskiyou County: Kangaroo Creek, 3; Mt. Shasta, 6 (U. S. Nation. Mus., 3; Mus. Vert. Zool., 3); Shasta County: near Baird Station, 4 (Mus. Vert. Zool., 1; U. C. Dept. Zool., 3); Potter Creek Cave, 2 (U. C. Dept. Zool.); Humboldt County: Eureka, 8; Mendocino County: Sherwood, 2; Covelo, 1; Mt. Sanhedrin, 2 (Acad. Nat. Sci. Phila.); Tehama County: Mill Creek, 1; Yolo County: Rumsey, 1; Sacramento County: Folsom, 1 (Mus. Comp. Zool.); Colusa County: Snow Mountain, 1 (Stanford Univ.); Nevada County: Nevada City, 6 (U. S. Biol. Surv.); Placer County: Colfax, 8 (Stanford Univ.); Eldorado County: Mt. Tallac, 5 (Acad. Nat. Sci. Phila.); Fyffe, 13; Limekiln, 6; Echo, 1 (Stanford Univ.); Placerville, 3 (Stanford Univ.); Fallen Leaf Lake, 1; Sonoma County: Cloverdale, 1 (U. S. Nation. Mus.); Cazadero, 1; Guerneville, 3; Marin County: Nicasio, 24 (U. S. Nation. Mus.); Alameda County: Sunol, 1 (U. S. Biol. Surv.); Niles Cañon, 2 (Calif. Acad. Sci.); San Mateo County: Pescadero Creek, 3; Santa Clara County: Mountain View, 1 (Stanford Univ.); Monterey County: Monterey, 5; Pacific Grove, 1 (Stanford Univ.); Mariposa County: Yosemite Valley, 7 (U. S. Nation. Mus., 3; Mus. Vert. Zool., 4); Merced Lake, 7; Madera County: Raymond, 1;

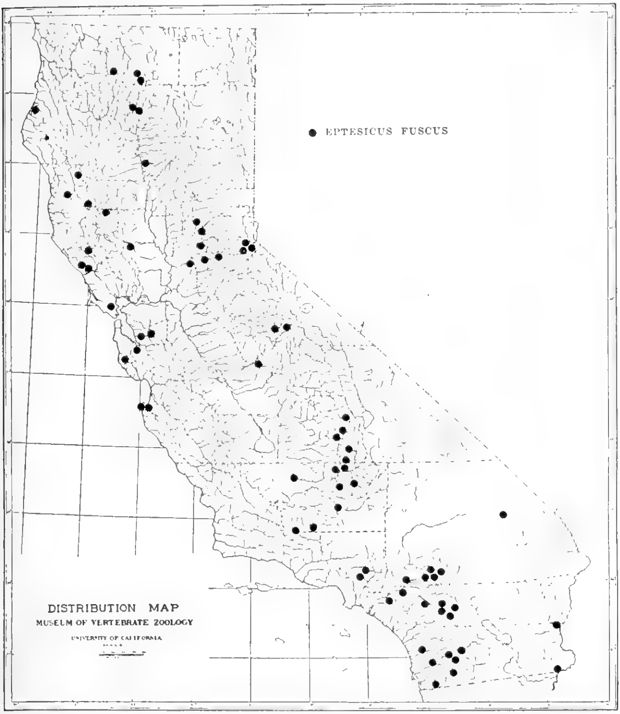

Fig. Q. Map showing stations of occurrence in California of *Eptesicus fuscus*, as established by specimens examined by the author. This species is most wide-ranging of all Californian bats.

Tulare County: Little Kern River, 3 (U. S. Biol. Surv.); Whitney Meadows, 1; Taylor Meadow, 1; Trout Creek, 6; Kern County: Posa Creek, 2 (U. S. Nation. Mus.); head of Kelso Valley, 1; Fay Creek, 2; Kernville, 1 (U. S. Biol. Surv.); Walker Basin, 4 (U. S. Biol. Surv.); Kern Lakes, 1 (U. S. Biol. Surv.); Tehachapi, 1 (U. S. Biol. Surv.);

Fort Tejon, 3; Ventura County: Mount Pinos, 3; San Bernardino County: Providence Mountains, 2 (U. S. Biol. Surv.); San Bernardino Valley, 1 (Acad. Nat. Sci. Phila.); San Bernardino Mountains, 31; Los Angeles County: near Pasadena, 14; west fork of San Gabriel River, 1; Orange County: Trabuco Cañon, 1; Riverside County: Riverside, 1 (Stanford Univ.); San Jacinto, 32 (Stanford Univ.); San Jacinto Mountains, 10; San Diego County: Escondido, 2; Foster, 1; Cuyamaca Mountains, 6; San Felipe Cañon, 2; Julian, 5; Pine Valley, 4 (U. S. Nation. Mus.); Dulzura, 2 (U. S. Nation. Mus.); Imperial County: Colorado River near Pilot Knob, 1; Palo Verde, 1.

Natural History.—J. Grinnell (1908, p. 159) reports the brown bat to have been the most common and generally distributed bat in the San Bernardino Mountains in the summers of 1905, 1906, and 1907. It came out early in the evening, often soon after sundown, and proved easy to secure by shooting. Specimens taken in August were excessively fat.

At Guerneville, Sonoma County, where three specimens were secured in the summer of 1913, these bats were invariably seen flying slowly and steadily high over the cañon bed, whereas the hoary bats flew low over the meadows, and the little California bats zigzagged in and out close about the tops of the young redwood growth. The large size and slow, steady flight of this bat render it comparatively easy to secure by shooting; hence the abundance of specimens in collections misrepresents its actual relative abundance among the various species of bats in the wild.

Bailey (1905, p. 211), when recording the large brown bat from Texas, states that he found two lower jaws of this bat, among numerous other bones, in pellets under the nest of a great horned owl.

Three females in the Museum of Vertebrate Zoology, each containing a single embryo, were secured on the following dates: April 22, June 10, and June 25. Adult females secured by Dixon at Fyffe, Eldorado County, between July 19 and 31, were considered by him (MS) as having ceased to nurse their young.

General Remarks.—An examination of a series of 278 specimens of the large brown bat, taken in California, shows the probable existence of two or even three races within the state. Specimens from the humid coast belt of northwestern California average very much darker than a series from the southeastern part of the state; yet individual variation is so great that until a much larger series of specimens becomes available for comparison it is impossible to define limits of range satisfactorily. For example, five specimens of *Eptesicus fuscus* in the Museum of Vertebrate Zoology, selected because of their close resemblance in color (bright buffy brown above, pale avellaneous beneath) were found to have come from the following widely separated localities: No. 2778, Julian, San Diego County; no. 6959, San Bernardino Mountains, San Bernardino County; no. 5145, near Pasadena, Los Angeles County; no. 5141, Mt. Pinos, Ventura County; no. 3286, Mt. Shasta, Siskiyou County.

In the original description of *E. f. bernardinus* (from a single specimen taken in the "San Bernardino Valley"), Rhoads (1901, p. 619) remarks that "a series of four specimens from the same collector taken in the 'San Bernardino Mts.' in September, 1893, shows that the mountain form is inseparable from *fuscus;* one of these, however, is a perfect intergrade." I have examined Rhoads' type (no. 8247, ♂, Acad. Nat. Sci. Phila.) and find it well within the range of individual variation of specimens from the San Bernardino Mountains, and darker than the two specimens at hand from the Colorado River.

J. Grinnell (1908, p. 159) comments as follows upon a series of skins of the large brown bat taken in the San Bernardino Mountains:

The series of thirty skins secured shows much variation in depth of color. Some are very light-colored, and these agree with Rhoads' subspecies *bernardinus.* But others are as dark as the darkest I have seen from elsewhere in central and southern California, so that I cannot perceive the existence of a race *bernardinus* if it is to be based on color characters alone; unless it be that all California examples differ from the eastern animal.

Grinnell and Swarth (1913, p. 382) remark concerning a series of nine large brown bats taken in the San Jacinto Mountains: "The specimens taken show much variation in color, and the remarks made in regard to a series from the San Bernardino Mountains apply here."

J. Grinnell (1914, p. 268) says of a single example of *Eptesicus fuscus* taken by the Colorado River expedition on the California side of the river near Pilot Knob:

The specimen secured (no. 10697) is an adult female. It appears to differ in small size and extreme paleness from the average of the species from California. It about equals in the latter respect the palest out of a series of ninety brown bats from the Pacific slope of California. The color dorsally is uniform isabella color, ventrally pale wood brown. Measurements: length 107 mm., tail vertebrae 44, foot 9, forearm 42.5, longest finger 72, ear (dry) 12. The skull, too, is appreciably small.

A general inspection of the Museum's series of this species from California points towards the existence within the state of at least three geographic races based on size and depth of color. But so much of the total area is unrepresented by specimens that systematic analysis at this time seems inadvisable.

Stone (1904*a*, p. 579) says of two specimens, male and female, of *Eptesicus fuscus* taken at Mount Sanhedrin, California: "These specimens are identical with topotypes of *E. fuscus* from Philadelphia."

Rehn (in Stone, 1904*b*, p. 590) states that *E. f. melanopterus* which he describes from Mount Tallac

> ... is no doubt closest related to *f. osceola* than any of the form[s] of *fuscus*. The original series of the former has been examined in this connection, and the differential characters were drawn from it. The relationship with true *fuscus* is not so close as an examination of a series of thirty specimens from, or within a radius of, twenty miles of the type locality shows. No close relationship exists with *E. f. bernardinus* Rhoads, which is a very pale type quite different from any of the forms here considered.

I have examined the type and four paratypes of *E. f. melanopterus,* which are in the Academy of Sciences of Philadelphia, and find them very nearly uniform in coloration with, and well within the range of individual color variation in, series of specimens from elsewhere in the United States and Canada. As Rehn states (*loc. cit.*), the skull is identical with that of the typical form.

Taking all the above testimony into consideration I feel that the subspecific splitting of *Eptesicus fuscus* in California is a difficult problem, and one which should not be undertaken until abundant material is available for comparison, from elsewhere in the United States and from the adjoining provinces of Canada and Mexico.

Genus **Nycteris** Borkhausen

This genus ranges from Central America north to the limits of tree growth in northern North America. It occurs also on the Greater Antilles, and on the Bahama, Galapagos and Hawaiian islands (Miller, 1907, p. 221). Two distinct species are known to occur north of Panama, one of which is divisible into at least five geographic races.

Characters.—Dental formula: $i\,\frac{1-1}{3-3},\ c\,\frac{1-1}{1-1},\ pm\,\frac{2-2}{2-2},\ m\,\frac{3-3}{3-3}=32.$ Upper incisors only two, short and robust, strongly converging at tips; height from cingulum to tip of crown less than twice greatest diameter of tooth. Lower incisors all closely alike, the shafts being widely separated and columnar in form; crowns abruptly widened, being at their bases twice width of shafts; crowns trilobed and imbricated; outer pair of lower incisors closely crowded against bases of canines. Canines well developed, the upper slightly the larger.

Anterior upper premolar minute, and crowded into inner angle between canine and large second premolar. First lower premolar scarcely half height of second. Cusps of lower molars more developed than those of upper molars.

Skull short and broad, greatest width at least two-thirds its length. Rostrum about two-thirds length of brain-case, and sloping abruptly downward from it anteriorly. (See pl. 23, figs. 49, 51; pl. 24, figs. 57, 59.) Auditory bullae greater in diameter than space between them. Zygomatic arches not expanded. Ear short and rounded; when laid forward reaching barely to mouth. Fifth finger much shorter than third, the difference between them about equaling length of thumb. Interfemoral membrane very large; most of its upper surface furred; length of tail vertebrae exceeding that of forearm. Mammae four.

Nycteris borealis teliotis (H. Allen)

Western Red Bat

Lasiurus noveboracensis, H. Allen (1864, pp. 15–20, figs. 13–17), part. Description; general distribution.

Lasiurus noveboracensis, Cooper (1868, p. 5). Distribution.

Lasiurus noveboracensis, Cooper (*in* Cronise, 1868, p. 442). Occurrence in California.

Atalapha teliotis H. Allen (1891, pp. 5–7). Original description of the subspecies found in California; precise type locality unknown.

Atalapha noveboracensis, Bryant (1891*a*, p. 358). Nominal.

Atalapha teliotis, Bryant (1891*b*, p. 113). Nominal.

Atalapha teliotis, Bryant (1892, p. 219). Nominal.

Atalapha teliotis, H. Allen (1894, pp. 153–155, pls. 27–28). Description.

Lasiurus borealis teliotis, Miller (1897*b*, pp. 110–111, figs. 29–30). Description; general distribution.

Lasiurus borealis teliotis, Elliot (1901, p. 413). Diagnosis; general distribution.

Lasiurus borealis teliotis, Miller and Rehn (1901, p. 262). Type locality (California).

Lasiurus borealis teliotis, Rehn (*in* Stone, 1904*b*, p. 591). Record of capture at Linden, San Joaquin County, June 2, 1898.

Lasiurus borealis teliotis, Elliot (1904*b*, pp. 593–594). Distribution; diagnosis.

Lasiurus borealis teliotis, Elliot (1905, p. 486). Distribution.

Lasiurus borealis teliotis, Stephens (1906, p. 271, 1 fig. in text). Description; distribution.

Lasiurus borealis teliotis, Elliot (1907, p. 513). Record of specimen taken at Monterey.

Lasiurus borealis teliotis, Lyon and Osgood (1909, p. 277). Nature and location of type.

Lasiurus borealis teliotis, Seton (1909, p. 1185). Map showing record stations and hypothetical range.

Nycteris borealis teliotis, Miller (1912, p. 64). General range.

Nycteris borealis teliotis, J. Grinnell (1913*b*, p. 280). Range in California.

Diagnosis.—Size medium (forearm 34 to 41.3 millimeters long); whole dorsal surface of interfemoral membrane furred; color ranging from rufous red or fawn to yellowish gray, some of the hairs tipped with whitish.

Description: Head.—Muzzle short and broad; nostrils directed outward and downward, apertures in an alcoholic specimen 2 millimeters apart. Eye small and inconspicuous. A glandular swelling on each side of head between nostril and eye. In an alcoholic specimen the ears when laid forward reach barely to the mouth. Anterior border of ear strongly but irregularly convex from free point of anterior basal lobe to tip; through this portion of its periphery it forms almost a semicircle. Posterior border of ear concave from tip to one-third distance to posterior basal lobe, and convex on remaining two-thirds. Tragus slightly more than half height of ear, and triangular in general outline with tip directed forwards.

Limbs and Membranes.—Wing attached at base of toes. Foot less than half length of tibia; claws strongly curved. Calcar slender, about twice as long as foot and considerably shorter than free border of interfemoral membrane; not lobed at tip in the specimens at hand. Tail unusually long (5 to 15 millimeters longer than forearm) and enclosed to extreme tip in interfemoral membrane (pl. 18, fig. 14).

Pelage.—Fur everywhere full and soft; longest on dorsal surface between shoulders, where the maximum length is about 10 millimeters. Ear furred only on basal two-thirds of its dorsal surface; ventral surface of ear scantily haired along borders; otherwise naked. Fur on dorsal surface of wing continuous with that on body to a line running from ankle joint to about middle of humerus; otherwise naked save for three small patches of hair, the first lying at base of thumb, the second extending along both sides of basal third of fifth metacarpal, and the third occupying anterior angle formed by junction of radius and humerus; ventral surface of wing membrane furred from just behind anterior border to a line extending from knee joint to basal third of third metacarpal. The fur constituting this strip is thicker and longer at the base of the fifth metacarpal than elsewhere. Whole dorsal surface of interfemoral membrane furred; but its ventral surface furred only at extreme base. Dorsal surface of toes furred.

Color.—Hairs black at bases, except on face, chin, and membranes. In general, hairs on face and chin are yellowish, tipped with rufous. Hairs on back black for 1.5 millimeters from base; succeeding 7 millimeters pale yellowish; distal to this a rufous band about 1 millimeter wide, followed by an ashy tip of 0.5 millimeter. Ashy tips often lacking on posterior portion of back, as also on dorsal surface of interfemoral membrane. On the latter area the black at bases of the hairs may also be wanting.

I am informed by Messrs. Miller and Hollister of the United States National Museum that in the eastern red bat the males are, on the average, brighter colored than the females, it being possible in most specimens to determine the sex by color alone. I find that this does not hold true with our western subspecies. McAtee (1907, p. 8) mentions the resemblance of an individual of the eastern red bat to a withered leaf caught among the twigs of a tree. This suggests a protective value for the reddish brown color of our species.

MEASUREMENTS IN MILLIMETERS OF ELEVEN SPECIMENS OF NYCTERIS BOREALIS TELIOTIS (H. ALLEN), FROM CALIFORNIA

Mus. no.	Sex	Locality	Total length	Tail vertebrae	Tibia	Foot	Forearm	Greatest length of cranium	Zygomatic breadth	Breadth of brain-case	Interorbital constriction
3277	♂	Berkeley, Alameda Co.	98.0	45.0	19.8	11.0	41.3	12.8	9.3	7.8	4.5
4048	♂	Westley, Stanislaus Co.	102.0	50.0	17.0	8.0	36.0	12.0	8.5	7.0	4.4
4049	♂	Westley, Stanislaus Co.	104.0	52.0	19.2	8.0	39.0	12.6	9.0	7.7	4.6
4674	♂	Napa, Napa Co.	101.0	42.0	17.0	8.0	37.7	12.0	8.8	7.4	4.4
5146	♂	Pasadena, Los Angeles Co.	105.0	52.0	19.4	8.0	39.0	12.7	9.3	7.8	4.9
6958	♂	Glendora, Los Angeles Co.	106.0	52.0	19.3	6.0	40.0	12.6	9.2	7.8	4.5
18794	♂	Escondido, San Diego Co.	99.0	52.0	......	9.0	40.0	12.4	9.0	7.5	4.3
16598	♀	Live Oak, Sutter Co.	105.0	54.0	......	7.5	39.6	12.6	9.4	7.5	4.3
16670	♀	Cuyama Valley, San Luis Obispo Co.	109.0	49.0	18.4	9.0	34.0	12.7	....	7.7	4.3
21438	♀	Fresno, Fresno Co.	111.0	60.0	19.7	10.0	40.5	12.4	9.6	7.5	4.1
24327	♀	Fresno, Fresno Co.	110.0	48.0	17.3	9.0	......	13.1	9.3	8.0	4.5

Skull.—As described for the genus. May always be distinguished from that of *Nycteris cinerea*, by its decidedly smaller size (pl. 23, fig. 51, and pl. 24, fig. 59). The average skull length of the examples of *cinerea* in the Museum of Vertebrate Zoology is 17.5 millimeters, while that of the series of *teliotis* is but 12.5 millimeters.

Measurements.—Average and extreme measurements in millimeters of a series of 11 specimens in the Museum of Vertebrate Zoology are as follows: Total length, 104.5 (extremes, 98.0–111.0); tail vertebrae, 50.5 (42.0–60.0); tibia, 18.5 (17.0–19.7); foot, 8.5 (6.0–11.0); forearm, 38.7 (34.0–41.3); greatest length of skull, 12.5 (12.0–13.1).

Synonymy and History.—This bat was described by H. Allen (1891, pp. 5–7) under the name *Atalapha teliotis*. The description was based on a poor specimen without data, but presumably taken in southern California. This type is now number 84555, in the United States National Museum (Lyon and Osgood, 1909, p. 277).

Distribution.—The general range of *Nycteris borealis teliotis* is given by Miller (1912, p. 64) as follows: "From the head of Sacramento Valley, California, south to Comondu, Lower California." J. Grinnell (1913*b*, p. 280) gives the California range in winter and spring as Sacramento and San Joaquin valleys, from Sutter County southwards, and throughout the San Diegan district. (See map, text-fig. R.) A study of the dates of capture of California red bats leads the present writer to infer that the sexes separate during the summer months, the females remaining in the Lower Sonoran zone, while the males migrate into the Upper Sonoran and Transition zones.

Among certain species of birds the males withdraw from the breeding grounds in early summer and forage elsewhere, often at higher elevations. Their departure relieves congestion in the nesting area and leaves a greater food-supply for the females and young. A study of the summer distribution of red bats in California leads one to believe that a similar habit exists among these vertebrates also. Of the red bats listed, with dates of capture, in the accompanying table, the nineteen adult females taken between April 15 and August 1 are all recorded from the Lower Sonoran zone; whereas of the four adult males taken during the same time of the year three are from the Transition zone and the fourth from the Upper Sonoran. All winter records of red bats, of both sexes, are from the two Sonoran zones.

Specimens Examined.—The writer has examined 56 examples of this bat from California. Since the seasonal movements of the California red bat have not been fully worked out, it seems pertinent to give here the date as well as locality of capture of each specimen. The entire list appears on an accompanying table.

Natural History.—The western red bat is a solitary, tree-dwelling species. It spends its days hanging in foliage. Stephens (1906, p. 271) states that all that he has seen were found in spring or summer hanging in fruit trees in orchards.

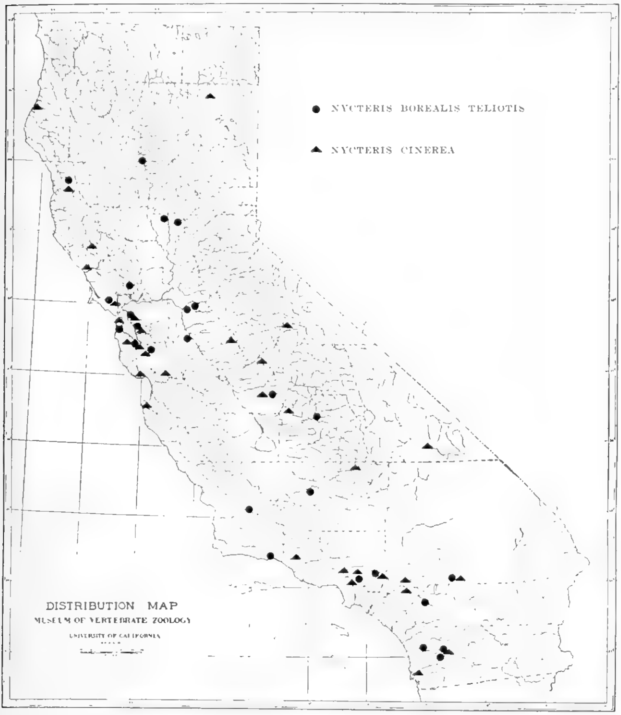

Fig. R. Map showing stations of occurrence in California of *Nycteris borealis teliotis* and *Nycteris cinerea,* as established by specimens examined by the author.

One of the western red bats in the Museum of Vertebrate Zoology (no. 18794) was found hanging among the evergreen leaves of an orange tree near Escondido, San Diego County, October 8, 1912.

TABLE SHOWING LOCALITIES (ARRANGED FROM NORTH TO SOUTH) AND DATES OF CAPTURE OF NYCTERIS BOREALIS TELIOTIS (H. ALLEN) IN CALIFORNIA

No.	Sex	Locality	Date	Collector
65375 Biol. Surv.	♂ ad.	Tehama Co.: Tehama	May 14, 1894	C. P. Streator
23897	♂	Mendocino Co.: near Laytonville	Apr. 2, 1916	F. C. Clarke
16599	♀ ad.	Yuba Co.: Hammonton	Apr. 15, 1912	J. W. Hagar
16600	♀ ad.	Yuba Co.: Hammonton	Apr. 15, 1912	J. W. Hagar
16598	♀ ad.	Sutter Co.: Live Oak	May 3, 1912	W. D. Pierce
4674	♂ ad.	Napa Co.: Napa	Oct. 15, 1908	C. L. Camp
6974 Amer. Mus.	♂ ad.	Marin Co.: Nicasio	Aug. 26, 1891	C. A. Allen
11675 Phila. Acad.	♀ ad.	San Joaquin Co.: Linden	June 2, 1898	A. S. Bunnell
24176	♀ juv.	San Joaquin Co.: Stockton	July 12, 1915	Mrs. F. H. Holden
24177	♂ juv.	San Joaquin Co.: Stockton	July 12, 1915	Mrs. F. H. Holden
24178	♂ juv.	San Joaquin Co.: Stockton	July 12, 1915	Mrs. F. H. Holden
24179	♀ ad.	San Joaquin Co.: Stockton	July 12, 1915	Mrs. F. H. Holden
3277	♂ ad.	Alameda Co.: Berkeley	Dec. 22, 1903	A. S. Bunnell
132344 Biol. Surv.	....	Alameda Co.: Haywards	Mar. 28, 1904	W. O. Emerson
23898	♀ ad.	Alameda Co.: Berkeley	Apr. 8, 1916	Mrs. J. L. Schlisinger
U. C. Dept. Zool.	♂ ad.	Alameda Co.: Berkeley	Oct. 17, 1898	Miss Reed
105250 Nat. Mus.	♀ ad.	San Mateo Co.: Colma	Nov. 27, 1900	J. Hornung
Stanford Univ.	♂ ad.	Santa Clara Co.: Palo Alto	Nov. 7, 1893	N. G. Buxton
Stanford Univ.	....	Santa Clara Co.: Palo Alto	Jan. 12, 1910	J. O. Snyder
Stanford Univ.	....	Santa Clara Co.: Stanford University	Sept., 1893	J. M. Stowell
Stanford Univ.	....	Santa Clara Co.: Stanford University	Sept., 1893	J. M. Stowell
Stanford Univ.	♂ ad.	Santa Clara Co.: Stanford University	May 10, 1900	O. Jenkins
Stanford Univ.	♂ ad.	Santa Clara Co.: Palo Alto	Oct. 3, 1893	W. W. Price
Stanford Univ.	♂ ad.	Santa Clara Co.: San Jose	Feb., 1897	A. W. Greely
4048	♂ ad.	Stanislaus Co.: Westley	Feb. 12, 1909	L. Brookey
4049	♂ ad.	Stanislaus Co.: Westley	Feb. 23, 1909	L. Brookey
21438	♀ ad.	Fresno Co.: Fresno	Apr. 3, 1915	A. Borell
21514	♀ ad.	Fresno Co.: Fresno	May 21, 1915	E. Borell
21515	♀ ad.	Fresno Co.: Fresno	May 21, 1915	E. Borell
21516	♀ ad.	Fresno Co.: Fresno	May 21, 1915	E. Borell
21902	♀ ad.	Fresno Co.: Fresno	May 28, 1915	E. and R. Borell
21903	♀ ad.	Fresno Co.: Fresno	May 28, 1915	E. and R. Borell
21904	♀ ad.	Fresno Co.: Fresno	May 28, 1915	E. and R. Borell
21905	♀ ad.	Fresno Co.: Fresno	May 28, 1915	E. and R. Borell
21906	♀ ad.	Fresno Co.: Fresno	May 28, 1915	E. and R. Borell
21907	♀ ad.	Fresno Co.: Fresno	June 23, 1915	E. Borell
21908	♂ juv.	Fresno Co.: Fresno	June 23, 1915	E. Borell
21909	♂ juv.	Fresno Co.: Fresno	June 23, 1915	E. Borell
21910	♂ juv.	Fresno Co.: Fresno	June 23, 1915	E. Borell
21911	♀ ad.	Fresno Co.: Fresno	June 23, 1915	E. Borell
21912	♂ juv.	Fresno Co.: Fresno	June 23, 1915	E. Borell
21913	♂ juv.	Fresno Co.: Fresno	June 23, 1915	E. Borell
21914	♂ juv.	Fresno Co.: Fresno	June 23, 1915	E. Borell

No.	Sex	Locality	Date	Collector
31177 Biol. Surv.	♂ ad.	Tulare Co.: Three Rivers	Sept. 16, 1891	A. K. Fisher
16670	♀ ad.	San Luis Obispo Co.: Cuyama Valley	Apr. 22, 1912	J. Grinnell
54602 Biol. Surv.	....	Santa Barbara Co.: Santa Barbara	May 20, 1893	H. K. Chamberlain
30729 Biol. Surv.	♀ ad.	Kern Co.: Bakersfield	July 17, 1891	V. Bailey
6958	♂ ad.	Los Angeles Co.: Glendora	Dec. 10, 1903	W. S. Wood
187714 Nat. Mus.	♂ ad.	Los Angeles Co.: Alhambra	Dec. 28, 1880	E. C. Thurber
Coll. F. Stephens	♀ ad.	San Bernardino Co.: Warren's Ranch	May 15, 1903	F. Stephens
Stanford Univ.	♂ ad.	Riverside Co.: San Jacinto	Nov. 15, 1893	E. Hyatt
18794	♂ ad.	San Diego Co.: Escondido	Oct. 8, 1912	J. Dixon
2515 Coll. F. Stephens	♂ ad.	San Diego Co.: Witch Creek	May 25, 1895	F. Stephens
62870 Nat. Mus.	....	San Diego Co.: Witch Creek	June 19, 1895	A. W. Anthony
716 Coll. F. Stephens	♀ ad.	San Diego Co.: Santa Ysabel	Aug. 15, 1896	F. Stephens
60533 Nat. Mus.	♂ ad.	San Diego Co.: Santa Ysabel	June 15, 1892	F. Stephens

Another (no. 6958) was found hanging in an orange tree at Glendora, Los Angeles County, December 10, 1903. The female red bat (no. 21438) secured by Adrey Borell at Fresno, April 3, was found hanging in a mulberry tree in company with "many" more of its kind and one hoary bat, which was also captured.

In some portions of its general range the red bat is migratory, while in others it is said to hibernate in vast numbers in caves. The latter report needs to be verified. This subject is treated more fully under the heading Migration, on page 232.

In most bats the number of mammae is two, but in the bats of the genus *Nycteris* the number is four. This fact might lead to the inference that in this genus there is a greater number of young than in other genera. Observations made by Lyon (1903, pp. 425–426) and Ward (1905, p. 20) establish the fact that as many as four young occur at a single birth. Lyon records the capture at Washington, D. C., of a female eastern red bat weighing 11 grams. Clinging to her nipples were four young whose combined weights were 12.7 grams. Combining his own information with that given by Lyon, Ward gives the following summary of observations upon the number of young clinging to, or embryos found in, adult females of the genus *Nycteris:* two with one, two with two, three with three, two with four.

Among the female western red bats in the Museum of Vertebrate Zoology are five which contained embryos, and three captured with young. Of the former, four contained three embryos each and the fifth, two. Each of the three mothers had three young clinging to her. Two of the mothers were found in adjoining peach trees at Fresno, June 23, 1915. Of these two, no. 21907, when discovered, had three small naked young clinging to her, all males; the young clinging to no. 21911 were also all males, but were twice the size of the individuals in the other family. The third mother, no. 24179, was found at Stockton, on July 12, 1915. The bat was clinging to the trunk of a tree one and one-half feet above the ground, with her young attached. Her weight was 12.4 grams and the weights of her three half-grown young were: two males, 6.5 each; one female, 6.4; total, 19.4 grams. (See pl. 18, fig. 18.)

Nycteris cinerea (Peale and Beauvois)

Hoary Bat

Vespertilio cinereus Peale and Beauvois (1796, p. 15). Original description; type locality, Pennsylvania.

Lasiurus cinereus, H. Allen (1864, pp. 21–24, figs. 18–20). Description; specimens recorded from Petaluma and Monterey.

Lasiurus cinereus, Cooper (1868, p. 5). Distribution.

L[asiurus]. cinereus, Cooper (*in* Cronise, 1868, p. 442). Occurrence in California.

Atalapha cinerea, Dobson (1878, pp. 272–274). Description; specimen listed from Monterey.

Atalapha cinerea, Bryant (1891*a*, p. 358). Nominal.

Atalapha cinerea, H. Allen (1894, pp. 155–162, pls. 29–31). Description.

Lasiurus cinereus, Miller (1897*b*, pp. 112–115, figs. 31–32, pl. 3, fig. 4). Description; distribution; lists several California localities.

Lasiurus cinereus, Elliot (1901, p. 413). Diagnosis; general distribution.

Lasiurus cinereus, Stone (1904*b*, p. 587). Record of occurrence at Berkeley.

Lasiurus cinereus, Elliot (1904*b*, p. 595, fig. 88). Diagnosis; general distribution.

Lasiurus cinereus, Stephens (1906, p. 272). Description; distribution; habits.

Lasiurus cinereus, Elliot (1907, pp. 513–514). Record of specimen taken at Nicasio.

Lasiurus cinereus, Seton (1909, p. 1193). Map showing record stations and hypothetical range.

Nycteris cinerea, Miller (1912, p. 64). General range.

Nycteris cinerea, J. Grinnell (1913*b*, p. 280). Range in California.

Diagnosis.—Size large (forearm 49 to 56.6 millimeters long): whole dorsal surface of interfemoral membrane furred; color, yellowish brown, conspicuously tipped with silvery white.

Description: Head.—Muzzle broad; greatest width of rostrum about one-half entire length of head (pl. 16, fig. 8). Nostrils directed obliquely outward and slightly downward, and their rims widely diverging, tumid; space between them concave and, in dried skins, their openings more than 3 millimeters apart. Ear short, about 18 millimeters in height from meatus, and broad, only 1 millimeter less wide than high; external basal lobe about size of tragus and not notched on its anterior border; tragus somewhat triangular in outline and about half height of ear from crown.

Limbs and Membranes.—Wings unusually long (extent almost three times total length of body) and narrow; third metacarpal exceeding fifth by at least length of thumb (pl. 16, fig. 7). Wings and interfemoral membranes attached at bases of toes. Tip of tail included in interfemoral membrane; tail unusually long, length of caudal vertebrae exceeding that of forearm by from 4 to 11 millimeters.

Pelage.—Fur similar to that of red bat, everywhere full and soft, and longest on dorsal surface between shoulders, where from 10 to 12 millimeters in length. Outer side of ear furred on lower half; a strip of hair near anterior edge of ventral surface of ear; a squarish patch of hairs on ventral surface of ear in front of apex; basal lobe furred on outside. Tragus scantily haired on outer surface. Dorsal surface of wings furred as follows: a line of fur, continuous with that of body and of dorsal surface of interfemoral membrane, extends from ankle along surface of wing to anterior edge of antebrachial membrane opposite middle of humerus (pl. 17, fig. 10); along each side of radius is a scanty growth of short hairs, averaging less than 1 millimeter in length, except for oblong patch of longer and denser fur on proximal fifth of forearm on edge nearest body. Another patch of fur lies at the proximal end of the fifth metacarpal; from this a scanty line of hairs extends along sides of metacarpal for one-third its length. A third patch of fur lies at base of thumb. On ventral surface of wing a line of fur continuous with that of body extends from knee joint to distal end of radius, where it fills the angles between the finger joints and extends outwardly along inner edge of third metacarpal for two-thirds its length. Ventral surface of antebrachial membrane furred except at its anterior edge. Dorsal surface of interfemoral membrane entirely furred, as also the dorsal surfaces of the toes.

Color.—Dorsal surface of rostrum, all hairs on ears, a band about 8 millimeters wide extending across throat and uniting ears, and fur on under surface of wings, near naples yellow; fur on wings nearest body, with brownish base. Sides of muzzle, rims of ears, and chin, blackish brown. Hairs on whole back and dorsal surface of tail seal brown for about 2 millimeters at bases, then light buff for another 2 or 3 millimeters, followed by seal brown for about 1.5 millimeters, and terminated by a white tipping on the distal end of each. Bands of buff are missing from hairs on dorsal surface of tail.

On ventral surface of body a ruff of hairs, similar to those on back, encircles throat just posterior to the band of naples yellow. Posterior to this the hairs have bases of light seal brown, and tips of light buff. On the dorsal surface of the wing the three small patches of fur (2 millimeters in diameter) are pale buff in color.

Wing membranes nearest chaetura black, except area on dorsal surface directly above furred portion of ventral surface, which is light cinnamon brown; specklings of this color extend out onto the darker portions of membranes.

According to Miller (1897*b*, p. 113) the color variation, although considerable, is never enough to obscure the characters of the species and appears to be wholly independent of locality, certain skins from such widely separated regions as Minnesota and southern California being practically indistinguishable.

Skull.—Similar to that of *Nycteris borealis teliotis* but larger (pl. 23, fig. 49, and pl. 24, fig. 57). In *N. b. teliotis* the skull length varies from 12 to 13.1 millimeters, while in *N. cinerea* it is from 16.9 to 18.5 millimeters.

Measurements.—Average and extreme measurements in millimeters of a series of 14 skins in the Museum of Vertebrate Zoology are as follows: Total length, 135.1 (extremes 128.0–146.0); tail vertebrae, 57.7 (51.0–62.0); tibia, 20.4 (19.0–22.5); foot, 11.1 (10.0–12.0); forearm, 51.8 (49.0–56.6); greatest length of skull 17.5 (16.9–18.5).

Synonymy and History.—The hoary bat was first described by Peale and Beauvois (1796, p. 15) from a specimen secured in Pennsylvania, probably near Philadelphia.

Distribution.—The general range of this bat is given by Miller (1912, p. 64) as extending throughout "boreal North America from the Atlantic to the Pacific, breeding within the Boreal Zone, but in autumn and winter migrating at least to the southern border of the United States." The range in California in winter and spring comprises the valleys of west-central and southern California, south through the San Diegan district; in summer probably the Transition and Boreal zones. (See map, text-fig. R.)

The accompanying table shows very few strictly summer records of the hoary bat in California. It is possible that many of the individuals wintering here come from breeding areas north of this state. A discussion of the migration of this bat is given in the present paper under the heading Migration, on page 232.

Specimens Examined.—The writer has examined 55 examples of the hoary bat from California. Since the seasonal movements of this species are not fully known the writer has included in the accompanying table the dates of capture as well as the localities from which specimens have been secured.

Natural History.—Several hoary bats have been found hanging in the thick foliage of orange trees in southern California in the winter. On April 17, 1904, H. S. Swarth discovered one clinging to a branch of an oak tree, looking like some huge gall. Stephens found the species in the redwoods of Mendocino County in May. He records

MEASUREMENTS IN MILLIMETERS OF FOURTEEN SPECIMENS OF NYCTERIS CINEREA (PEALE AND BEAUVOIS), FROM CALIFORNIA

Mus. no.	Sex	Locality	Total length	Tail vertebrae	Tibia	Foot	Forearm	Greatest length of cranium	Zygomatic breadth	Breadth of brain-case	Interorbital constriction
5147	♂	Nordhoff, Ventura Co.	130.0	57.0	19.6	11.0	51.0	17.4	12.6	10.2	5.4
6944	♂	Glendora, Los Angeles Co.	135.0	59.0	19.0	10.0	52.2	17.2	12.0	10.0	5.4
9467	♂	Los Angeles, Los Angeles Co.	140.0	58.0	......	11.0	54.0	18.5	13.2	11.0	5.2
14650	♂	Raymond, Madera Co.	128.0	51.0	19.0	11.0	50.0	17.3	12.4	10.0	5.5
14651	♂	Raymond, Madera Co.	130.0	55.0	21.6	11.0	51.0	17.4	12.3	10.1	5.3
14652	♂	Raymond, Madera Co.	137.0	57.0	22.5	11.0	50.0	......	12.8	10.3	5.4
20778	♂	Berkeley, Alameda Co.	140.0	62.0	......	12.0	51.3	17.4	12.3	10.1	5.2
21311	♂	Berkeley, Alameda Co.	129.0	58.0	......	11.5	51.3	......	......	......	5.3
20815	♂	1 mi. west Guerneville, Sonoma Co.	131.0	56.0	......	12.0	51.5	17.2	12.6	10.0	5.1
3581	♀	Monterey, Monterey Co.	145.0	59.0	21.0	12.0	56.6	17.8	......	10.0	5.2
21439	♀	Fresno, Fresno Co.	132.0	59.0	20.7	11.0	49.0	17.9	13.0	10.3	5.2
6945	♀	San Fernando Valley, Los Angeles Co.	131.0	58.0	20.0	11.0	50.4	16.9	12.1	10.1	5.3
5148	♀	Pasadena, Los Angeles Co.	138.0	58.0	20.2	10.0	51.5	17.8	12.7	10.3	5.1
5033	♀	Dinuba, Tulare Co.	146.0	61.0	......	12.0	55.5	17.8	12.3	10.3	5.3

Table Showing Localities (Arranged from North to South) and Dates of Capture of Nycteris cinerea (Peale and Beauvois) in California

No.	Sex	Locality	Date	Collector
16651 Biol. Surv.	..	Humboldt Co.: Eureka	May 25, 1889	T. S. Palmer
98095 Biol. Surv.	♂	Lassen Co.: Haydenhill	July 16, 1899	V. Bailey
711 Stanford Univ.	♂	Mendocino Co.: Cahto	May 24, 1889	R. C. McGregor
1101 Amer. Mus.	♂	Marin Co.: Nicasio	Oct. 17, 1887	C. A. Allen
1099 Amer. Mus.	♂	Marin Co.: Nicasio	Oct. 5, 1887	C. A. Allen
187824 Nation. Mus.	..	Marin Co.: Nicasio	Oct. 19, 1888	C. A. Allen
187825 Nation. Mus.	..	Marin Co.: Nicasio	Oct. 25, 1888	C. A. Allen
22301 Nation. Mus.	..	Marin Co.: Nicasio	Sept. 4, 1891	C. A. Allen
59988 Nation Mus.	..	Marin Co.: Nicasio	Sept. 15, 1891	C. A. Allen
187822 Nation. Mus.	♂	Marin Co.: Nicasio	Sept. 14, 1888	C. A. Allen
187823 Nation. Mus.	♂	Marin Co.: Nicasio	Oct. 13, 1888	C. A. Allen
20815	♂	Sonoma Co.: 1 mi. W. Guerneville	July 11, 1913	J. and H. W. Grinnell
16516 Biol. Surv.	♂	Sonoma Co.: Cloverdale	Apr. 18, 1889	T. S. Palmer
20778	♂	Alameda Co.: Berkeley	Feb. 6, 1914	Sam Brodie
11673 Phila. Acad.	..	Alameda Co.: Berkeley	Apr. 7, 1898	A. S. Bunnell
U. C. Dept. Zool.	♂	Alameda Co.: Berkeley	Dec. 6, 1905	—— ——
U. C. Dept. Zool.	♀	Alameda Co.: Berkeley	May 1, 1912	—— ——
U. C. Dept. Zool.	♂	Alameda Co.: Berkeley	Dec. 5, 1905	—— ——
21312	♂	Alameda Co.: Berkeley	Jan. 10, 1915	W. C. Newberry
U. C. Dept. Zool.	♂	Alameda Co.: Berkeley	Dec. 7, 1900	—— ——
119948 Biol. Surv.	..	Alameda Co.: Haywards	Feb. 6, 1902	W. O. Emerson
105259 Nation. Mus.	..	San Francisco Co.: San Francisco	Feb. 1, 1909	J. Hornung
331 Stanford Univ.	♂	Santa Clara Co.: Stanford University	Feb. 27, 1909	J. Dixon
9406 Mus. Comp. Zool.	..	Santa Clara Co.: Palo Alto	Apr. 11, 1898	W. W. Price
1438 Stanford Univ.	♂	Santa Clara Co.: Stanford University	Apr. 27, 1894	J. VanDenburgh
1437 Stanford Univ.	♂	Santa Clara Co.: Stanford University	Apr. 28, 1894	— Magee
Stanford Univ.	♂	Santa Clara Co.: Menlo Park	Jan. 23, 1893	—— ——
Stanford Univ.	♂	Santa Clara Co.: Santa Clara	May 1, 1893	J. M. Hyde
Stanford Univ.	♀	Santa Clara Co.: Menlo Park	Dec. 31, 1894	F. G. Krauss
199608 Nation. Mus.	..	Santa Clara Co.: Gilroy	Mar. 22, 1915	H. Doud
Stanford Univ.	..	Santa Clara Co.: Mountain View	Apr. 3, 1896	E. M. Ehrhorn
Calif. Acad. Sci.	♂	Santa Clara Co.: Mountain View	May 29, 1905	H. O. Jenkins
23899	..	Merced Co.: Snelling	Apr. 15, 1916	J. Grinnell
23039	♀	Mariposa Co.: Merced Lake	Aug. 21, 1915	C. A. Gallo
14650	♂	Madera Co.: Raymond	Apr. 17, 1911	J. Grinnell
14651	♂	Madera Co.: Raymond	Apr. 17, 1911	J. Grinnell
14652	♂	Madera Co.: Raymond	Apr. 21, 1911	J. Grinnell
21439	♀	Fresno Co.: Fresno	Apr. 3, 1915	Adrey Borell
17058 Biol. Surv.	♀	Santa Cruz Co.: Santa Cruz	Oct. 5, 1910	C. P. Streator

No.	Sex	Locality	Date	Collector
3581	♀	Monterey Co.: Monterey	Nov. 10, 1907	J. Rowley
5033	♀	Tulare Co.: Dinuba	Apr. 1, 1909	A. L. Dickey
27977 Biol. Surv.	♀	Inyo Co.: Panamint Mts.	May 17, 1891	E. W. Nelson
28946 Biol. Surv.	♂	Inyo Co.: Panamint Mts.	Apr. 21, 1891	E. W. Nelson
5147	♂	Ventura Co.: Nordhoff	Jan. 18, 1905	J. Grinnell
29845 Biol. Surv.	♂	Kern Co.: 25 mi. above Kernville	July 6, 1891	A. K. Fisher
5148	♀	Los Angeles Co.: Pasadena	Feb. 5, 1906	J. Grinnell
3423	..	Los Angeles Co.: Los Angeles	May ...., 1890	E. C. Thurber
6944	♂	Los Angeles Co.: Glendora	Dec. 29, 1906	J. Grinnell
6945	♀	Los Angeles Co.: San Fernando Valley	May 7, 1904	J. Grinnell
9467	♂	Los Angeles Co.: Los Angeles	Apr. 17, 1904	H. S. Swarth
8248 Phila. Acad.	..	San Bernardino Co.: San Bernardino Valley	Apr. 24, 1893	R. B. Herron
125801 Biol. Surv.	..	San Bernardino Co.: Warren's Ranch	May 15, 1902	F. Stephens
Coll. F. Stephens	♂	Riverside Co.: Riverside	Feb. 21, 1889	F. O. Johnson
Coll. F. Stephens	♀	San Diego Co.: San Diego	Dec. 20, 1903	F. Stephens
53810 Biol. Surv.	..	San Diego Co.: Santa Ysabel	May 10, 1893	H. W. Hyatt

the flight as swift, with frequent abrupt turns, and states that these bats do not appear until the light becomes very dim.

A female hoary bat secured at Merced Lake, Mariposa County, was shot at 7:12 P.M. on the cloudy evening of August 21, 1915, as it flew among the lodgepole pines at a height of about thirty feet above the ground.

Merriam (1884, pp. 176–181) gives an interesting account of this bat as occurring in the Adirondack region of New York state. There the hoary bat was the latest of the observed species to appear in the evening. Merriam states that this bat may be recognized in the dark by its great size, long and pointed wings, and the swiftness and irregularity of its flight.

Seton (1909, p. 1169) states that the hoary bat is the only known species which is never gregarious. As occurring in California it is certainly a notably solitary species. The only evidence to the contrary is afforded by the female hoary bat secured at Fresno, April 3, 1915, which was found hanging in a mulberry tree is company with "many" red bats.

Seton (1909, p. 1196) states that four is the usual number of young at birth. Banta (*in* McAtee, 1907, p. 8) states that there is in the museum at the University of Indiana a female hoary bat which when captured was found to have two young clinging to it.

Genus **Euderma** H. Allen

This genus, as at present known, consists of a single species, found only in the southwestern United States.

Characters.—Ears very large, about three-fourths as long as forearm, joined across forehead by band of membrane; nostrils simple, facial portion of skull narrow and pointed, the brain-case quadrate, flattened above, but rising abruptly at frontal border; zygomata abruptly expanded at middle; auditory bullae very large, and much elongated, their greatest diameter about equal to length of tooth-row exclusive of incisors.

Dental formula: i $\frac{2-2}{3-3}$, c $\frac{1-1}{1-1}$, pm $\frac{2-2}{2-2}$, m $\frac{3-3}{3-3} = 34$. Upper incisors alike in form, slender, with well developed cingula, and simple styliform crowns, the inner somewhat larger than the outer, which is in contact, or nearly so, with canine. Lower incisors trifid, middle lobe largest, especially in second and third. Upper canine small and weak, barely more than twice height of inner incisor, which it rather closely resembles in form. Lower canine relatively smaller than in any other known Vespertilionine bat, its crown scarcely higher than that of fourth lower premolar. Anterior upper premolar minute, scarcely more than one-third as large as outer incisor and rising barely to cingulum of canine; in the tooth-row it stands at the middle of the narrow space between the canine and large premolar, and in form resembles the incisors, but its crown is relatively lower and thicker; large premolar of usual form, but very deeply concave on anterior border. Lower premolars of ordinary Vespertilionine type; molars normal. [As no skull of *Euderma* is at hand, the above description has been adapted from Miller (1907, pp. 225–227).]

Comparisons.—In length of ears and form of skull and teeth this genus is said to resemble *Plecotus* and *Corynorhinus*, but its simple nostrils are of the *Myotis* type.

Euderma maculatum (J. A. Allen)

Spotted Bat

Histiotus maculatus J. A. Allen (1891*a*, pp. 195–198). Original description; type locality near Piru, Ventura County, California.

Histiotus maculatus, Bryant (1891*b*, p. 113). Nominal.

Histiotus maculatus, H. Allen (1892, pp. 467–470). As type of the new genus *Euderma*.

Euderma maculatum, Bryant (1892, p. 220). Nominal.

Euderma maculata, H. Allen (1894, pp. 61–64). Description.

Euderma maculatum, Miller (1897*b*, pp. 46–49, pl. 3, fig. 3). Description.

Euderma maculata, Elliot (1901, p. 398). Description; distribution.

Euderma maculatum, Miller and Rehn (1901, p. 265). Type locality.

Euderma maculatum, Elliot (1904*b*, p. 283). Reference to type locality.

Euderma maculatum, Elliot (1905, p. 490). Distribution.

Euderma maculatum, Stephens (1906, p. 264). Description; distribution.

Euderma maculatum, Miller (1907, pp. 226–267, 1 fig.). Description of genus.

Euderma maculatum, J. Grinnell (1910, pp. 317–320, pl. 30). Second record from California.

Euderma maculatum, Miller (1912, p. 67). Nominal.

Euderma maculatum, J. Grinnell (1913*b*, p. 281). Range in California.

Diagnosis.—Same as for the genus.

Description: Head.—Ears (pl. 16, fig. 9) very large, and in the dried skin at hand widely diverging at tips, fully three-fourths as long as forearm, and joined across forehead by a low band of membrane; ear convex on inner border, broadly rounded at tip, slightly concave on outer border just below tip, and convex on basal half of outer border, which continues as a low fold to a point below angle of mouth. Tragus well developed, 19 millimeters in length (in dried skin), this being more than one-third length of ear; posterior border convex above small basal lobe, tip broadly rounded, and anterior border straight on upper half, but slightly convex below. As suggested by Miller (1897*b*, p. 47) the tragus resembles in form the blade of a table knife. Nostrils prominent and situated at end of a narrow, low, naked disc, divided by a slight groove, and narrowing posteriorly to a point.

Limbs and Membranes.—Forearm slightly bowed; thumb with a small basal pad. Wing short and stout, length of third metacarpal scarcely exceeding that of fifth. Wing and tail membranes wholly devoid of hair. About half of last caudal vertebra exserted. Feet moderately large, a little less than half as long as tibia. Toes very scantily haired.

Pelage.—Fur soft, silky, and about 8 millimeters in length, save for a small woolly patch at posterior base of each ear.

Color.—The small woolly patches of fur at bases of ears are whitish throughout. Elsewhere on body all hairs are blackish either on the proximal third or for their entire length. On the dorsal surface of the animal are three equal-sized white patches of fur about 9 by 17 millimeters in extent, one on each shoulder, and one on the rump (pl. 16, fig. 9). As suggested by J. Grinnell (1910, p. 318) these remind the observer of the "death's-head" pattern of certain moths. The hair in these patches is, as elsewhere, blackish at base. On the ventral surface, the distal third of the hair is everywhere white, save for a narrow collar of blackish hairs continuous with blackish fur of back. In a dried skin which has been preserved for five years the ear membranes are yellowish, other membranes pale brown.

Skull.—As given for the genus.

Measurements.—The accompanying table of measurements has been compiled from published descriptions of specimens.

Synonymy and History.—This bat was first described by J. A. Allen (1891*a*, pp. 195–198) from a single specimen found "caught on a fence at Piru, in the western part of Ventura County, California." This specimen was secured by a Los Angeles taxidermist, Thomas Shooter, and through E. C. Thurber transmitted to the

Measurements in Millimeters of Three Examples of Euderma maculatum (J. A. Allen)

Mus. no.	Sex	Date	Total length	Tail vertebrae	Tibia	Foot	Forearm	Greatest length of cranium	Zygomatic breadth
1196[1]	?	Oct. 1, 1907	....	......	18.0	....	45.0	......	......
122545[2]	♂ ad.	Sept., 1903	107.0	47.0	19.6	9.8	49.6	18.8	10.4
3920/2991[3]	....	March, 1890	110.0	50.0	21.0	9.8	50.0	19.0	10.9

[1] From Mecca, Riverside County, California.
[2] U. S. National Museum: from Mesilla Park, New Mexico.
[3] Amer. Mus. Natural History: from Piru, Ventura County, California.

American Museum of Natural History. Dr. C. Hart Merriam (*in* Miller, 1897*b*, p. 49) gives the added information that the type was in reality taken at the mouth of Castac Creek, in the Santa Clara Valley; this is eight miles from Piru, in the same valley, but across the line in Los Angeles County.

Because of its general resemblance, as regards size, and the form and size of the ears, to *Histiotus* of South America, Dr. J. A. Allen placed the bat in that genus. H. Allen (1892, pp. 467–470) placed the bat in the new genus *Euderma*, separating it from *Histiotus* upon the presence of a minute first upper premolar, absent in the latter genus.

Distribution.—The spotted bat is known from only four localities, in each of which but a single individual has been secured. The localities and dates are as follows: near Piru, Ventura County, California (see above), the type, March, 1890 (J. A. Allen, *loc. cit.*); Mecca, Imperial County, California, an individual found dead in the overflow from a railway watering tank, October 1, 1907 (J. Grinnell, 1910, p. 317); Mesilla Park, New Mexico, an individual found dead in the biological laboratory of the New Mexico College of Agricultural and Mechanical Arts, in September, 1903 (Miller, 1903, p. 165); Yuma, Arizona, one reported by Herbert Brown (Stephens, 1906, p. 264). (See map, text-fig. O.)

Dr. C. Hart Merriam (*in* Miller, 1897*b*, p. 49) states that while in Vegas Valley, Nevada, he was told of the occurrence there, during the summer, of a very large bat "with ears like a jackass and a white stripe on each shoulder."

Specimens Examined.—The writer has seen but one example of *Euderma maculatum* from California: Mecca, Riverside County, 1.

Natural History.—Nothing is known of the habits of this species.

Genus **Corynorhinus** H. Allen

This genus is found only in the warmer portions of North America, from southern British Columbia to southern Mexico. Three species are now recognized, one of which is divisible into four races.

Diagnosis.—Ears very long, about three-fourths length of forearm; tragus slender, pointed at tip and wholly free from external basal lobe of ear.

Description: Head.—Muzzle slender; greatest width of rostrum less than one-third total length of skull. This slenderness, however, is somewhat concealed by club-shaped glandular masses which rise on each side of snout, between nostril and eye, to a height of 2.5 millimeters (in an alcoholic specimen) above surface of rostrum, the two of which converge nearly to meet in the median line. Nostrils irregularly quadrate and placed on sides of muzzle, opening outwards and slightly upwards; borders of nostrils slightly thickened, giving them a rimmed appearance. Ears very large (text-fig. S), being about three-fourths length of forearm, and joined across forehead by a narrow band of membrane. Tragus straight and slender, about two-fifths height of ear. Anterior border of auricle strongly convex and turned abruptly backward so as to rest upon dorsal surface of ear almost to its bluntly rounded tip. Posterior half of ear marked by a series of transverse veinings, most prominent near center of ear and fading away towards its posterior border. (See pl. 15.)

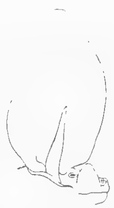

Fig. S. Side view of head of *Corynorhinus rafinesquii pallescens* (drawn from specimen no. 9368), × 1.00, showing long ear, long acutely pointed tragus, and glandular swelling on side of muzzle.

Skull and Teeth.—Skull slender, with compressed zygomata; brain-case elongate and rounded, in profile slightly depressed on top and convex anteriorly; rostrum concave in profile, sloping abruptly downward from its junction with brain-case. Auditory bullae large and rounded; their greatest diameter equal to about three times distance between them. (See pl. 23, fig. 50; pl. 24, fig. 58.)

Dental formula: $i\,\frac{2-2}{3-3},\ c\,\frac{1-1}{1-1},\ pm\,\frac{2-2}{3-3},\ m\,\frac{3-3}{3-3}=36$. Inner upper incisor about one-third higher than outer, and frequently bicuspidate; in western specimens this character varies greatly. Lower incisors about equal in height and slightly crowded in the tooth-row; exceeded in height by cingulum of canine. First upper unicuspid (pm^2) minute, the second (pm^4) unusually broad, its greatest width equaling its height from cingulum to tip. First and second lower unicuspids (pm_2 and pm_3) small, less than two-thirds height of third (pm_4); all conical and with complete cingula. Cusps of lower molars particularly high and sharp.

Limbs and Membranes.—Wing short and broad, length of fifth metacarpal equaling that of third; wing membrane attached at side of metatarsus, just below bases of toes. Calcar neither keeled nor lobed, slightly less in length than free edge of interfemoral membrane. Length of foot about half that of tibia. Tail exceeds forearm in length by from 2 to 10 millimeters. All membranes relatively thin and delicate.

Pelage.—Fur everywhere full and soft, longest on middle portion of back, where it reaches a maximum length of 11 millimeters. Face naked save for occasional long hairs rising from the glandular masses, and a fringe of shorter finer hairs extending downward along sides of upper lip. Fur reaches onto dorsal base of ear for a distance of 2 or 3 millimeters. Wings and interfemoral membrane naked except at their extreme bases.

Corynorhinus rafinesquii pallescens Miller

Pale Lump-nosed Bat

Synotus Townsendii, Cooper (*in* Cronise, 1868, p. 442). Occurrence east of the Sierras.

Synotus Townsendii, Cooper (1868, p. 6) (?).

Corynorhinus macrotis pallescens Miller (1897*b*, pp. 52–53, figs. 9–10). Original description; type locality, Keam Cañon, Arizona.

Corynorhinus macrotis pallescens, Elliot (1901, pp. 399–400). Diagnosis; distribution.

Corynorhinus macrotis pallescens, Elliot (1904*b*, p. 604). Diagnosis; distribution.

Corynorhinus macrotis pallescens, Elliot (1905, p. 491). Distribution.

Corynorhinus macrotis pallescens, Stephens (1906, p. 265). Diagnosis; distribution; habits.

Corynorhinus macrotis pallescens, Miller (1912, p. 67). General range.

Corynorhinus macrotis pallescens, Grinnell and Swarth (1913, pp. 379–380). Occurrence in San Jacinto region; habits.

Corynorhinus macrotis pallescens, J. Grinnell (1913*b*, p. 281). Range in California.

Corynorhinus macrotis pallescens, J. Grinnell (1914, p. 263). Occurrence at Riverside Mountain, Colorado River.

Corynorhinus macrotis pallescens, H. W. Grinnell (1914, p. 320). Comparison with *C. m. intermedius.*

Corynorhinus megalotis pallescens, G. M. Allen (1916, pp. 341–344), part. Description; status of subspecies; list of localities.

Diagnosis.—Color wood brown; total length, 92 to 101 millimeters, averaging 97.2.

Description: Color.—Dorsal surface wood brown, becoming paler about head; hairs with faintly defined light plumbeous bases. Ventral surface vinaceous buff; membranes a slightly darker shade of same color. G. M. Allen (1916, p. 342) discusses color variation in *C. r. pallescens* and records minutely the shading of two "reddish" individuals (10694, 10695, Mus. Vert. Zool.) secured in a mine at Riverside Mountain on the Colorado desert. J. Grinnell had earlier stated (1914, p. 263) that the reddish cast of these two specimens "is doubtless wholly adventitious, due to the fine, sticky red dust with which the walls of the mine were covered."

A specimen in the Museum of Comparative Zoology collected in the hills back of Lone Pine is stated by G. M. Allen (*loc. cit.*) to be "'pale pinkish buff' above and nearly white below to the roots of the hairs."

Measurements.—Average and extreme measurements in millimeters of a series of ten specimens from the San Jacinto Mountain region are as follows: total length, 97.2 (extremes, 92.0–101.0); tail vertebrae, 47.7 (43.0–50.0); tibia, 18.1 (15.9–19.3); foot, 9.0 (8.0–11.0); forearm, 39.9 (37.5–41.8); greatest length of skull, 15.9 (15.5–16.4).

MEASUREMENTS IN MILLIMETERS OF TEN SPECIMENS OF CORYNORHINUS RAFINESQUII PALLESCENS MILLER FROM NEAR KENWORTHY, SAN JACINTO MOUNTAIN REGION, CALIFORNIA

Mus. no.	Sex.	Total length	Tail vertebrae	Tibia	Foot	Forearm	Greatest length of cranium	Zygomatic breadth	Mastoid breadth	Interorbital constriction
1883	♂	97.0	46.0	18.0	8.0	39.3	16.0	8.3	8.8	3.4
1885	♂	92.0	46.0	17.5	8.0	39.3	15.5	8.2	8.5	3.4
1887	♂	98.0	49.0	18.7	8.0	38.5	16.3	8.5	9.0	3.6
1888	♂	93.0	46.0	15.9	8.0	37.5	16.4	8.2	8.8	3.5
1889	♂	99.0	50.0	18.0	9.0	40.1	15.9	8.2	9.0	3.6
1890	♂	93.0	43.0	18.0	11.0	41.7	15.8	8.0	8.9	3.5
1891	♂	100.0	49.0	18.7	10.0	39.6	16.4	8.6	8.9	3.6
1892	♂	101.0	50.0	18.1	10.0	39.8	15.8	8.3	8.9	3.5
1884	♀	98.0	48.0	19.0	8.0	41.8	16.1	8.4	8.8	3.5
1893	♀	101.0	50.0	19.3	10.0	41.0	15.9	8.2	9.0	3.4

Synonymy and History.—*Corynorhinus macrotis* [=*rafinesquii*] *pallescens* was described by Miller (1897*b*, pp. 52–53) from specimens captured in Keam Cañon, Navajo County, Arizona. This author regarded *pallescens* as a race of the *Corynorhinus macrotis* described by LeConte (1831, p. 431). LeConte does not designate a type locality, but Miller (1897*b*, p. 51) fixes the type locality as the LeConte Plantation, in Georgia. G. M. Allen (1916, pp. 338–341) in a revision of the genus *Corynorhinus* states that the species of *Corynorhinus* occurring west of the Alleghanies is distinct from the one described by LeConte, and revives the name *megalotis* of Rafinesque for the western animal. Later, Oldfield Thomas (1916, p. 127) finds the name *megalotis* preoccupied, and to have been replaced with the name *rafinesquii* by Lesson (1827, p. 96).

I have examined certain of the specimens in the United States National Museum upon which G. M. Allen based his opinion, and concur with him in recognizing the distinctness of the two species, and the nearer affinity of Californian *Corynorhinus* with the form *rafinesquii.* G. M. Allen (*loc. cit.*) fails to recognize the race *intermedius,* placing some individuals so called by the present writer with the race *pallescens* and others with *townsendii.* This matter is discussed on page 347 of the present paper.

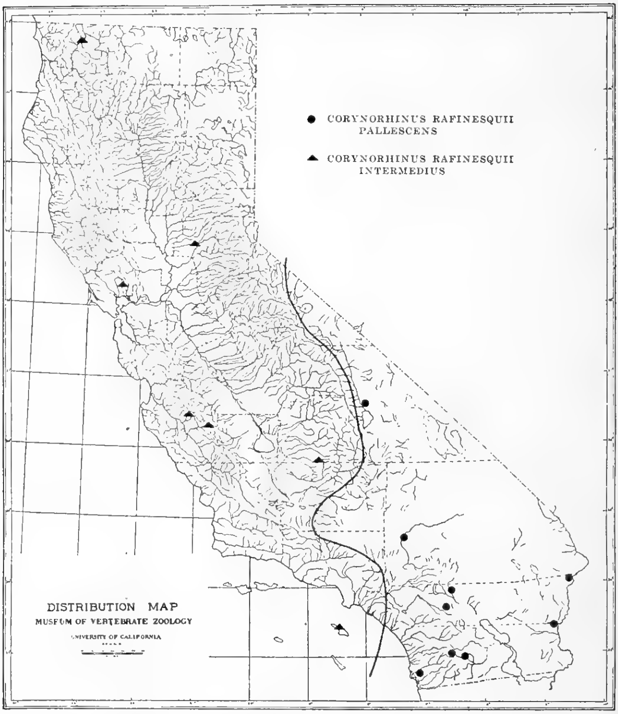

Fig. T. Map showing stations of occurrence in California of *Corynorhinus rafinesquii pallescens* and *Corynorhinus rafinesquii intermedius,* as established by specimens examined by the author.

Distribution.—The distribution of this bat has not been fully worked out, but indications are that it will be found to occur throughout the arid portions of the southwestern United States and extreme northern Mexico (see G. M. Allen, 1916). In California it has been found in the Lower and Upper Sonoran zones, chiefly on the Colorado and Mohave deserts. (See map, text-fig. T.)

Specimens Examined.—Total number 28, from the following localities in California: Imperial County: Palo Verde, 1; San Diego County: Julian, 1; Vallecito, 2; San Diego, 1 (San Diego Soc. Nat. Hist.); Riverside County: near Kenworthy, San Jacinto region, 17; Riverside Mountain, near Colorado River, 2; Whitewater, 1; San Bernardino County: Oro Grande, 2 (U. S. Biol. Surv.); Inyo County: Lone Pine, 1 (Mus. Comp. Zool.).

Natural History.—Stephens (1906, p. 265) states that the pale lump-nosed bat appears to inhabit caves. All specimens of this bat which have been taken in California have been, as far as the writer is aware, captured in caves or mine tunnels, with the exception of those secured by Stephens at Vallecito, San Diego County. This collector writes (MS) that at Vallecito there is an old adobe house, vacant and without windows or doors. When camped in the vicinity Stephens made a practice of filling the windows with brush and hanging blankets above the doorways, ready to be let down. After dark a lantern was taken into the building and the blankets let down. As the bats flew about they were secured with a butterfly net. They did not come into the building until some time after dark, often an hour after the last rays of daylight. The only bats secured in the above manner were of the genera *Corynorhinus* and *Macrotus*.

The seventeen specimens taken May 22 and June 5, 1908, at Kenworthy, San Jacinto Mountains, were secured in an old mine tunnel some 600 feet in length and were found scattered along singly, clinging to the sidewalls from a few feet within the entrance nearly to the end. The bats were cold and scarcely able to move. The ears were folded down the sides and almost completely hidden by the wings which were held together in front, that is, against the rock. A female among the bats taken here contained one large embryo (see Grinnell and Swarth, 1913, pp. 379–380). Of these seventeen specimens fifteen were males.

J. Grinnell (1914, p. 263) reports the finding on March 18, 1900, of three bats of this species clinging to the rock wall at the end of the sloping drift in the Steece copper mine at Riverside Mountain, on the Colorado Desert. Both of the specimens secured were females and one contained a single embryo.

Because of its fondness for caves and tunnels this bat is well known to miners, who, in recognition of its long ears call it the "burro bat."

On March 15, 1915, a live male *Corynorhinus r. pallescens* was sent to the Museum of Vertebrate Zoology by Mr. W. C. Hanna, who found it on March 13, in a cave near Whitewater, Riverside County. When received at the Museum the bat was cold and torpid and the long ears were folded backward and downward and against the sides of the head; the long narrow tragi, however, stood rigidly erect (pl. 17, fig. 12). The ears were not bent sharply back, but curved by a regular and even crimping of the folds along the inner edges of the auricles, the effect thus produced reminding one strongly of the curving horns of a mountain sheep (pl. 15, fig. 4).

When the bat was taken into a warm room and handled his ears gradually unbent (pl. 15, fig. 5) until they stood erect and directed slightly forward (pl. 15, fig. 6). He soon became lively and protested in shrill cicada-like notes, and when released he quickly took flight.

The aerial motions of the little mammal were fascinating to watch as it repeatedly circled the room in its search for an exit. At one moment it was drifting as easily and slowly as a butterfly on a summer breeze, at another it was skimming as swiftly as a swallow, down almost to the surface of the floor, then up among the recesses of the beamed ceiling, an instant hovering where a draft of air came through the crack beside the closed door, then over to each window in turn, hovering up and down before the pane, touching nothing but the light cord which hung from the edge of each window-shade, and which retreated before the fanning wings.

A wild bird loosed in a room stirs one to instant pity by its headlong dash against the window glass; but the wild bat aroused only keenest admiration, for the dexterity of his searching flight was such that not a hair was ruffled.

Tired by his long flight the bat at last retreated to a beam of the ceiling where he hung in a shaded recess, head down, but ears and eyes alert. Finding himself unmolested his vigilance gradually relaxed, his eyes closed, his ears curled backwards, the tip of his tail curled under him, his thumbs turned back under his wings, the tiny claws thus aiding in the supporting of his body, and he was asleep.

Corynorhinus rafinesquii intermedius H. W. Grinnell

Intermediate Lump-nosed Bat

Corynorhinus macrotis townsendii, J. Grinnell (1913*b*, p. 281). Record from Placer County.

Corynorhinus macrotis intermedius H. W. Grinnell (1914, p. 320). Original description; type from Auburn, Placer County.

Corynorhinus megalotis pallescens, G. M. Allen (1916, pp. 341–344), part. Description; localities of record.
Corynorhinus megalotis townsendii, G. M. Allen (1916, pp. 344–347), part. Description; localities of record.

Diagnosis.—Similar in general characters to *Corynorhinus rafinesquii pallescens* Miller and *Corynorhinus rafinesquii townsendii* (Cooper), but intermediate in color between these two forms; darker colored and larger than *pallescens*.

Description.—As compared with *pallescens*, *intermedius* is somewhat larger in general size; ten examples of the latter form from Auburn, Placer County, average 102 millimeters in total length, while ten specimens of *pallescens* from the San Jacinto region average but 97.2 in the same dimension. In color *intermedius* is natal brown above; below, wood brown; membranes bone brown.

Measurements.—A series of ten specimens from west-central California shows averages and extremes in millimeters as follows: Total length, 102 (extremes, 97.0–108.0); tail vertebrae, 48.6 (45.0–55.5); tibia, 19.7 (18.7–21.0); foot, 9.8 (9.0–12.5); forearm, 42.0 (40.2–43.6); greatest length of skull, 16.2 (15.4–17.1).

Distribution.—The evidence at hand indicates that this bat occupies a geographic position intermediate between that of *pallescens* and that of *townsendii*, namely the semi-arid and semi-humid portions of the Upper Sonoran zone in California west of the desert divides. (See map, text-fig. T.)

Specimens Examined.—Total number, 44, from the following localities in California: Tulare County: Eclipse Mine, White River, 12 (Stanford Univ.); Placer County: Auburn, 23; Pioneer Cave, 3; Santa Catalina Island: Johnson Harbor, 1; Napa or Sonoma County: Mount Veeder, 1 (U. S. Biol. Surv.); Siskiyou County: Happy Camp, 1 (U. S. Biol. Surv.); San Benito County; Bear Valley, 2 (U. S. Biol. Surv.); Hernandez, 1 (Calif. Acad. Sci.).

Natural History.—There are in the Museum of Vertebrate Zoology three females of *intermedius* taken in Pioneer Cave, Placer County, May 12, 1870, by J. G. Cooper; and five females and one male taken at Auburn, Placer County, July 31, 1909, by Dr. J. C. Hawver. On August 6, 1913, Dr. Hawver secured fifteen females and two males in the belfry of the grammar school at Auburn. Dr. Hawver stated in a letter that these bats occur at Auburn the year around, showing no signs of being migratory.

Remarks.—An example of *intermedius* from Mount Veeder, on the border between Napa and Sonoma counties, varies strongly in the direction of *townsendii*. While Mount Veeder is not exactly within the humid coast belt, yet it lies in a region where there is a strong

Measurements in Millimeters of Ten Examples of Corynorhinus rafinesquii intermedius H. W. Grinnell, from California

Mus. no.	Sex	Locality	Date	Total length	Tail vertebrae	Tibia	Foot	Forearm	Greatest length of cranium	Zygomatic breadth	Mastoid breadth	Interorbital constriction
7754	♀	Auburn, Placer Co.	July 31, 1909	103.0	48.0	20.8	9.0	43.6	17.1	9.1	9.5	3.8
7753	♀	Auburn, Placer Co.	July 31, 1909	100.0	51.0	21.0	9.0	43.3	16.7	9.9	9.5	3.5
7752	♀	Auburn, Placer Co.	July 31, 1909	102.0	46.0	20.0	9.0	41.2	16.2	8.5	8.8	3.5
7755	♀	Auburn, Placer Co.	July 31, 1909	97.0	48.0	20.0	9.0	41.4	16.1	8.4	9.1	3.5
7756	♀	Auburn, Placer Co.	July 31, 1909	100.0	47.0	21.0	9.0	45.0	16.2	....	9.2	3.6
7757	♂	Auburn, Placer Co.	July 31, 1909	95.0	45.0	18.4	9.0	39.0	15.4	8.5	8.8	3.4
19214	♀	Auburn, Placer Co.	Aug. 6, 1913	108.0	55.5	19.0	11.0	43.5	......	....	....	....
150273[1]	..	Happy Camp, Siskiyou Co.	July 25, 1907	102.0	50.0	......	9.0	......	......	....	....	....
150826[1]	♀	Bear Valley, San Benito Co.	Nov. 9, 1907	106.0	52.0	19.0	12.0	41.0	16.2	8.9	9.1	3.7
150827[1]	♀	Bear Valley, San Benito Co.	Nov. 9, 1907	107.0	52.0	18.7	12.5	40.2	16.5	8.6	9.0	3.7

[1] From United States Biological Survey collection.

infusion of species belonging typically to the fauna of the humid coast district.

According to Miller (1897*b*, p. 53) *townsendii* is the form of *Corynorhinus macrotis* [= *rafinesquii*] occupying the humid coast belt of Oregon, Washington and British Columbia. No examples of any form of *Corynorhinus* which may occupy the humid coast district of northern California are available and it is entirely possible that the bats from this area may prove to be true *townsendii*.

G. M. Allen (1916, pp. 343–347) fails, in his revision of the genus *Corynorhinus*, to recognize the race *intermedius* and divides the type series between the races *pallescens* and *townsendii*. Of the nine skins of *intermedius* from the type locality which he examined, he places two as *pallescens*, "not typical," and the remaining seven as *townsendii*, "not all typical." A skin of *intermedius* from Catalina Island is listed as *pallescens*, "not typical." I have carefully reëxamined the series of skins upon which the name *intermedius* was based, and again compared it with series of *pallescens* and *townsendii*; but even with the aid of Dr. Allen's paper I am unable to relinquish my opinion that specimens from the semi-humid and semi-arid portions of west-central California constitute a recognizable race, *intermedius*. It would indeed be extraordinary if two *sub*species should have existed in a single colony!

Fig. U. Front view of head of *Antrozous pacificus*, × 1.00, showing nostrils opening forward beneath horseshoe-shaped ridges, long entirely separated ears, and long tapering tragi, with slightly crenulate posterior borders.

Subfamily Nyctophilinae

This subfamily, which is represented in North America by but a single genus, differs from the Vespertilioninae in the abruptly truncate muzzle, on the anterior face of which the nostrils open forward beneath a distinct horseshoe-shaped ridge or small nose-leaf (Miller, 1907, p. 234).

Genus **Antrozous** H. Allen

Ears separate (text-fig. U), extending considerably beyond tip of muzzle when laid forward; tragus slender, straight, tapering, a little less than half as high as ear conch; terminal joint of tail exserted. (For skull and teeth, see under species.)

The genus as occurring in California is represented by two closely related species, *Antrozous pallidus* and *A. pacificus.*

Antrozous pallidus (Le Conte)

Desert Pallid Bat

V[espertilio]. pallidus LeConte (1855, p. 437). Original description; type locality, El Paso, Texas (Baird, 1859, II, p. 5).

Vespertilio pallidus, Baird (1859, II, pp. 4–5), part. Description; recorded from "California."

Antrozous pallidus, H. Allen (1864, pp. 68–69, 3 figs. in text), part. Description; distribution (includes "Ft. Yuma").

Antrozous pallidus, Coues (1867, p. 283). Habits.

Antrozous pallidus, Cooper (1868, p. 6), part. Distribution.

Antrozous pallidus, Cooper (*in* Cronise, 1868, p. 442). Occurrence in California.

Antrozous pallidus, Coues and Yarrow (1875, pp. 85–86), part. Diagnosis; range; habits.

Antrozous pallidus, Dobson (1878, p. 171, pl. 11, figs. 6–6*b*). Description. Recorded from "California" and "Mammoth Valley, California."

Antrozous pallidus, Bryant (1891*a*, p. 358), part. Nominal.

Antrozous pallidus, H. Allen (1894, pp. 66–70, pl. 8), part. Description; distribution.

Antrozous pallidus pallidus, Miller (1897*b*, pp. 43–45, pl. 1, fig. 10, 4 figs. in text). Description; distribution; recorded from Fort Yuma, Owens Valley, Panamint Valley, and Walker Basin.

Antrozous pallidus, Elliot (1901, pp. 396–397, fig. 82). Description; general distribution.

Antrozous pallidus, Miller and Rehn (1901, pp. 266–267). Type locality.

Antrozous pallidus, Elliot (1904*a*, p. 319). Distribution in California; recorded from Lone Pine and Coso Mountains, in Inyo County.

Antrozous pallidus, Elliot (1904*b*, pp. 605–607, fig. 115). Description; general distribution.

Antrozous pallidus, Stephens (1906, p. 263, fig. in text). Description; distribution.

Antrozous pallidus, Elliot (1907, p. 518). Records repeated.

Antrozous pallidus pallidus, Lyon and Osgood (1909, pp. 278–279). Location and condition of type.

Antrozous pallidus pallidus, Miller (1912, p. 68). General range.

Antrozous pallidus pallidus, J. Grinnell (1913*b*, p. 282). Range in California.

Antrozous pallidus pallidus, J. Grinnell (1914, p. 263). Occurrence along Colorado River.

Diagnosis.—Forearm 46 to 51.4 millimeters long; greatest length of skull, 19.4 to 21.0; color, whitish drab gray.

Description: Head.—Muzzle squarely truncate, with a low but distinct horseshoe-shaped ridge above each nostril (text-fig. U); behind this, a large flattish swelling on each side. Ears separate and wide apart at bases, extending considerably beyond tip of muzzle when laid forward (pl. 17, fig. 11). Tragus slender, straight and long, half length of ear. Whole posterior border of tragus faintly crenulate; a well-developed lobe at posterior base.

Limbs and Membranes.—Wing short and broad; third metacarpal but slightly longer than fifth. Lateral membrane attached at bases of toes. Tip of tail exserted beyond interfemoral membrane. Length of calcar somewhat less than half that of free border of interfemoral membrane. Feet broad and strong, about half as long as tibia. Claws large and strong; chord of exposed portion of each claw about 2.5 millimeters long.

Pelage.—Fur on back silky, and about 8 millimeters in length. Fur on ventral surface shorter, averaging about 5 millimeters in length, and more abundant. Wing and tail membranes not furred except at their extreme bases. A narrow strip of hairs on dorsal surface of anterior border of ear, extending outward to about middle of border, and diminishing in width as it advances. On ventral surface of ear, lines of hair extend along two ridges which run parallel with anterior border of auricle. A few short hairs on backs of toes.

Color.—Hairs on back very pale drab gray, tipped on terminal fourth with pale brown. On under surface of body the hairs are grayish white, and toward sides of body suffused with a pale yellowish tint. Ears light brownish, wing membranes and feet darker.

Skull.—Greatest length varies from 19.4 to 21.0 millimeters. Brain-case, rostrum, and palate, broad. Length of bony palate behind molars (exclusive of median spine) slightly less than its width at base of median spine. Dorsal profile unevenly convex. Rostrum more than half as long as brain-case. Auditory bullae covering nearly the entire cochleae; their greatest diameter equal to twice the distance between them. (See pl. 23, fig. 55; pl. 24, fig. 63.)

Teeth.—Dental formula: $i\,\frac{1-1}{2-2},\ c\,\frac{1-1}{1-1},\ pm\,\frac{1-1}{2-2},\ m\,\frac{3-3}{3-3}=28$. Upper incisor large and simple, its shaft more than half as high as canine. Posterior basal lobe of incisor in contact with cingulum of canine. Lower incisors somewhat crowded; their trilobed crowns strongly imbricated. Upper and lower canines about equal in length, but former twice as wide at base as latter; cingula of both distinct but small. Upper premolar transversely long and narrow. First lower premolar small and narrow, closely wedged between canine and second premolar; latter equals first lower molar in height. First and second upper molars with middle cones highest. Third upper molar with less than half crown area of either of others, its outer cone highest. Lower molars with outer cusps much higher than inner.

Measurements.—Average and extreme measurements in millimeters of a series of eight specimens in the Museum of Vertebrate Zoology are as follows: Three males, total length, 104.0 (extremes, 99.0–111.0); tail vertebrae, 42.3 (40.0–47.0); tibia, 18.9 (18.4–19.4); foot, 11.3 (11.0–12.0); forearm, 47.4 (46.8–48.4); greatest length of skull, 19.7 (19.4–20.2); five females, total length, 112.3 (103.0–122.0);

tail vertebrae, 47.0 (41.0–53.0); tibia, 20.1 (19.0–21.0); foot, 11.8 (11.5–13.0); forearm, 50.9 (50.6–51.4); greatest length of skull, 20.6 (20.4–21.0).

Measurements in Millimeters of Nine Specimens of Antrozous pallidus (LeConte), from California

Mus. no.	Sex.	Total length	Tail vertebrae	Tibia	Foot	Forearm	Greatest length of cranium	Zygomatic breadth	Breadth of brain-case	Interorbital constriction
5837[1]	..	....	......	21.0	......	51.0	......	......	....	....
7340[2]	♀	122.0	53.0	21.0	13.0	50.8	21.0	12.5	10.0	4.2
7341[2]	♀	113.0	46.0	20.6	12.0	......	20.6	12.2	9.7	4.0
7342[2]	♀	103.0	41.0	20.0	11.5	51.4	20.6	12.2	9.4	3.9
7343[2]	♂	102.0	40.0	19.0	11.0	47.2	19.6	11.5	9.0	4.0
7344[2]	♂	99.0	40.0	18.4	11.0	46.8	19.4	11.6	9.2	3.9
7345[2]	♀	113.0	45.0	19.0	11.5	......	20.4	12.0	9.7	3.9
7346[2]	♂	111.0	47.0	19.4	12.0	48.4	20.2	11.8	9.3	4.1
10696[3]	♀	112.0	50.0	20.3	12.0	50.6	20.4	11.4	9.5	3.8

[1] From Swansea, Inyo County.
[2] From Vallecito, San Diego County.
[3] From Colorado River, Imperial County.

Synonymy and History.—*Antrozous pallidus* was first described by LeConte (1855, p. 437) under the name *Vespertilio pallidus*. In the original description the type locality is given as California, but both Baird (1859, II, p. 5) and H. Allen (1864, p. 69) have stated that the type material came from El Paso, Texas. The type is now in the United States National Museum and according to Lyon and Osgood (1909, pp. 278–279) is in a good state of preservation and clearly referable to the desert form.

H. Allen in 1862 (p. 247) made *pallidus* the type species of the new genus *Antrozous*.

Merriam in 1897 (p. 179) described the race of *Antrozous* from the region west of the deserts under the name *Antrozous pallidus pacificus*, showing it to be distinct from the form described by Baird.

Distribution.—The range of *A. pallidus* is given by Miller (1912, p. 68) as being the Lower Austral zone in the desert region of eastern California, Nevada, Arizona, New Mexico, and western Texas. Warren (1910, p. 284) gives two records for Colorado. In California this species occupies the Lower Sonoran zone on the Colorado and Mohave deserts. (See map, text-fig. V.)

Specimens Examined.—The writer has examined 9 specimens of this bat from the following localities in California: Imperial County:

Colorado River, 8 miles east of Picacho, 1; San Diego County: Vallecito, 7; Inyo County: Swansea, 1.

Natural History.—The earliest account of the habits of this species with which the writer is familiar is that given by Coues (1867, pp.

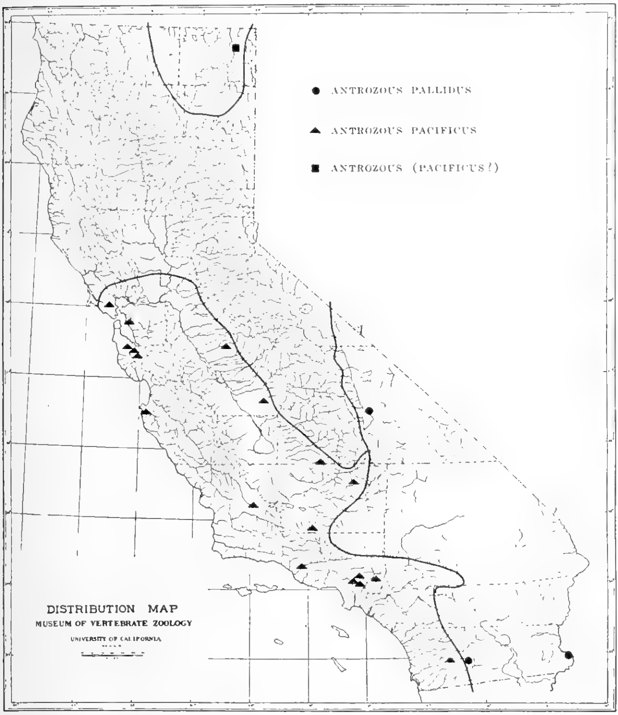

Fig. V. Map showing stations of occurrence in California of *Antrozous pallidus* and *Antrozous pacificus*, as established by specimens examined by the author.

283–284). This author found the desert pallid bat very abundant at Fort Yuma, where during the hot months it became a decided nuisance. The proximity of the crowded retreats of the bats in the chinks and crannies of the officers' quarters was actually offensive. At night the bats fluttered about the rooms by scores, and by day they could be continually heard scratching and squeaking in their retreats. When caught or disabled they squeaked harshly and bit with vigor and considerable effect, if incautiously handled.

Bailey (1905, pp. 214–215) reports these bats as occurring in western Texas between April 18 and October 11, but adds that these limits are apparently dates of collectors' entering and leaving the region rather than of the migration of the bats. During the day the bats were found by the collectors in crevices of buildings and behind signboards, and, as they occurred also in rocky country where there were no buildings, Bailey considers it probable that they there hid in crevices of the cliffs during the day. This author describes their flight as soft and noiseless, and while rapid, not so jerky and quick as that of most bats. He adds that the light color and large size render this species of bat unmistakable in the early evening.

J. Grinnell (1914, p. 263) states that a female taken April 20 on the Colorado River, eight miles east of Picacho, contained two embryos; and Stephens (MS) notes that a specimen taken at San Bernardino, May 16, contained three embryos.

Antrozous pacificus Merriam

Pacific Pallid Bat

Vespertilio pallidus, Baird (1859, II, pp. 4–5), part? Description; recorded from "California."

Antrozous pallidus, H. Allen (1864, pp. 68–69, 3 figs. in text), part. Description; recorded from "Posa Creek," Tejon Valley, and Ft. Tejon, Kern County.

Antrozous pallidus, Cooper (1868, p. 6), part. Distribution.

Antrozous pallidus, Coues and Yarrow (1875, pp. 85–86), part. Diagnosis; range; habits.

Antrozous pallidus, H. Allen (1894, pp. 66–70, pls. 8–9), part. Description.

Antrozous pallidus pacificus Merriam (1897, pp. 179–180). Original description; type locality, Fort Tejon.

Antrozous pallidus pacificus, Miller (1897*b*, pp. 45–46, 1 fig. in text). Description; distribution; several California localities listed.

Antrozous pallidus pacificus, Elliot (1901, p. 397). Diagnosis.

Antrozous pallidus pacificus, Miller and Rehn (1901, p. 267). Type locality.

Antrozous pallidus pacificus, Elliot (1904*a*, pp. 319–320). Occurrence at Fort Tejon; habits.

Antrozous pallidus pacificus, Elliot (1904*b*, p. 607). Diagnosis; distribution.

Antrozous pallidus pacificus, Stone (1904*b*, p. 587). Record of specimens secured at Berkeley.

Antrozous pallidus pacificus, Stephens (1906, p. 263). Diagnosis; distribution.

Antrozous pallidus pacificus, Elliot (1907, p. 518). Record of specimens taken at Fort Tejon and San Rafael.

Antrozous pallidus pacificus, Lyon and Osgood (1909, pp. 278–279). Location and condition of type.

Antrozous pallidus pacificus, Miller (1912, p. 68). General range.

Antrozous pallidus pacificus, J. Grinnell (1913*b*, p. 282). Range in California.

Diagnosis.—Forearm 53.7 to 58.9 millimeters; greatest length of skull, 22.0 to 23.9; color, yellowish drab brown.

Description.—In general characters *Antrozous pacificus* is very similar to *Antrozous pallidus*, but is slightly larger, with decidedly larger skull (pl. 23, fig. 53, and pl. 24, fig. 61), and darker coloration. Limbs, membranes, and pelage essentially similar to those of *pallidus*.

Color.—On the upper surface the hairs are pale yellowish drab at their bases, sepia or drab on distal third. The light bases of the hairs show in irregular patches. According to Stephens (1906. p. 263) there is a patch on the back of the neck, and sometimes one on the rump, where the dark tips are lacking. This is difficult to determine in some of the dried skins. On the under surface the hairs are cream color, slightly darker at the tips.

Skull.—The skull varies in greatest length from 22 to 23.9 millimeters. The brain-case, rostrum and bony palate are considerably broader than in *pallidus*. The length of the bony palate behind the molars (exclusive of the median spine) is usually equal to or greater than width at base of median spine.

Teeth.—The teeth are larger than those of *pallidus*, but similar in form, save that the upper premolar is conspicuously broader and shorter.

Measurements.—Average and extreme measurements of a series of seventeen specimens in the Museum of Vertebrate Zoology are as follows: ten males: total length, 118.0 (extremes, 109.0–125.0); tail vertebrae, 44.5 (39.0–49.0); tibia, 19.9 (19.0–22.0); foot, 13.1 (11.0–16.0); forearm, 55.0 (54.0–56.0); greatest length of skull, 22.4 (22.0–23.0); seven females: total length, 118.8 (114.0–122.0); tail vertebrae, 43.4 (41.0–46.0); tibia, 19.9 (18.0–21.7); foot, 13.4 (13.0–16.0); forearm, 55.3 (53.5–58.9); greatest length of cranium, 22.6 (22.0–23.9).

Synonymy and History.—H. Allen (1864, p. 68) remarked that in the species (*Antrozous pallidus*) two varieties of color are observed, but he does not attempt to separate the possible forms indicated. Many years later, C. H. Merriam (1897, pp. 179–180) described the darker race under the name *pacificus*, selecting his type from three specimens secured at Old Fort Tejon, California. The uniformly much larger skull of *pacificus*, together with lack of intergradation with *pallidus*, causes the present writer to consider *pacificus* a distinct species, rather than a race of *pallidus*.

Distribution.—The general range of *A. pacificus* is given by Miller (1912, p. 68) as "Austral zones of the western United States and

Measurements in Millimeters of Seventeen Examples of Antrozous pacificus Merriam, from California

Mus. no.	Sex	Locality	Total length	Tail vertebrae	Tibia	Foot	Forearm	Greatest length of cranium	Zygomatic breadth	Breadth of brain-case	Interorbital constriction
5188	♂	Pasadena, Los Angeles Co.	116.0	43.0	19.3	11.0	55.7	22.0	13.0	10.0	4.4
5190	♂	Pasadena, Los Angeles Co.	120.0	49.0	......	14.0	54.3	22.9	13.3	10.5	4.5
5243	♂	Pasadena, Los Angeles Co.	120.0	47.0	22.0	12.0	56.0	22.9	14.3	11.0	4.2
5245	♂	Pasadena, Los Angeles Co.	118.0	46.0	19.0	14.0	56.0	22.2	12.6	10.4	4.3
5246	♂	Pasadena, Los Angeles Co.	122.0	45.0	20.5	11.0	55.4	23.0	13.8	10.9	4.4
5248	♂	Pasadena, Los Angeles Co.	114.0	42.0	20.2	12.0	55.0	22.0	13.0	10.3	4.3
5250	♂	Glendora, Los Angeles Co.	125.0	49.0	19.5	13.0	55.0	22.7	13.4	10.3	4.0
5251	♂	Glendora, Los Angeles Co.	118.0	44.0	19.7	13.0	53.7	22.0	13.0	10.2	4.3
3867	♂	Palo Alto, Santa Clara Co.	109.0	41.0	19.0	15.0	55.0	22.2	13.0	10.3	4.0
3868	♂	Palo Alto, Santa Clara Co.	118.0	39.0	20.0	16.0	54.0	22.9	13.2	11.1	4.5
5189	♀	Glendora, Los Angeles Co.	115.0	42.0	21.7	13.0	53.5	22.2	12.9	10.5	4.3
5244	♀	Glendora, Los Angeles Co.	122.0	46.0	19.5	13.0	55.3	22.2	13.7	10.9	4.3
5247	♀	Glendora, Los Angeles Co.	122.0	46.0	18.0	13.0	54.0	23.0	13.6	10.7	4.2
5924	♀	Glendora, Los Angeles Co.	114.0	43.0	19.0	13.0	55.7	22.3	13.5	10.5	4.3
16326	♀	Kelso Valley, Kern Co.	115.0	41.0	19.6	13.0	53.9	22.0	12.9	10.4	4.3
14653	♀	Carrizo Plains, San Luis Obispo Co.	122.0	44.0	20.5	16.0	56.4	23.1	13.7	10.8	4.3
14654	♀	Carrizo Plains, San Luis Obispo Co.	122.0	42.0	21.6	16.0	58.9	23.9	13.8	11.3	4.5

northwestern Mexico.'' In California the range is through the Lower and Upper Sonoran zones on the Pacific slope, from the Mexican line north through the San Diegan district and San Joaquin Valley, and through the central coast district as far as Marin County. Recorded also from Fort Crook (near Burgettville), Shasta County (Miller, 1897*b*, p. 45). The specimen from Goose Lake, Modoc County, examided by me differs somewhat from other specimens of *Antrozous* which I have seen and suggests the existence in the northern part of the the Great Basin of a race, as yet unnamed, externally most nearly like *pacificus*. (See map, text-fig. V.)

Specimens Examined.—The writer has examined 107 specimens of the Pacific pallid bat from the following localities in California: San Diego County: Julian, 1; Los Angeles County: Glendora, 7 (U. S. Nation. Mus., 1; Mus. Vert. Zool., 6); Pasadena, 12; Sierra Madre, 3; Alhambra, 1 (U. S. Nation. Mus.); Ventura County: Santa Paula, 15 (Stanford Univ.); Kern County: Fort Tejon, 2 (U. S. Nation. Mus.); Kelso Valley, 1; San Luis Obispo County: Carrizo Plains, 2; Tulare County: White River, 1 (Stanford Univ.); Fresno County: Fresno, 3 (U. S. Nation. Mus., 2; Mus. Vert. Zool., 1); Monterey County: Carmel Mission, 2 (Stanford Univ.); Merced County: Snelling, 20; Santa Clara County: Palo Alto, 19 (Stanford Univ., 17; Mus. Vert. Zool., 2); Stanford University, 3 (Stanford Univ.); Mountain View, 1 (Stanford Univ.); San Mateo County: Menlo Park, 4 (Stanford Univ.); Alameda County: Berkeley, 8 (U. C. Dept. Zool., 4; U. S. Nation. Mus., 1; Mus. Vert. Zool., 3); Marin County: San Geronimo, 1 (Stanford Univ.); Modoc County: Goose Lake, 1 (San Diego Soc. Nat. Hist.).

Natural History.—During the summer of 1904 the writer became acquainted with a colony of the Pacific pallid bats which occupied the spaces under the eaves of a barn loft at Glendora, Los Angeles County, in company with a few Mexican free-tailed bats. Every morning the floor of the loft was found to be strewn with heads, legs, and wings of insects caught by the bats. Most numerous among these ''kitchen middens'' were heads and legs of Jerusalem crickets and the wings of sphinx moths. Dr. H. C. Bryant of the State Fish and Game Commission has kindly identified a sample lot of these remains, picked up in September, 1904, as belonging to the following genera and species of insects: *Prionus californicus, Stenopelmatus* sp., *Deilephila lineata, Microcentrum* sp., *Ligyrus gibbosus,* and *Gryllus* sp. It is of interest to note that the Jerusalem crickets (*Stenopelmatus*), being wingless, must have been secured upon the ground, the bats probably becoming aware of their whereabouts through hearing them as they crawled about on the surface of the ground.

Of six specimens of this bat taken from this colony August 6, 1904, four were females and two males, all adult.

Heller (*in* Elliot, 1904*a*, pp. 319–320) found this species rather rare at the type locality, Fort Tejon. He says of it:

> Several were secured while I was stopping in an old house. The bats could not be found in the house during the day, but at night they entered through the open windows, bringing with them large brown mole crickets, which they devoured at their leisure while suspended from the roof. The floor of the house below their perches was covered with the remains of the insects.

A female of this species (no. 14654) secured by Swarth and Carr May 27, 1911, at Painted Rock, Carrizo Plains, San Luis Obispo County, contained two embryos. Stephens (1906, p. 263) states that the young of this bat are born about the first of July. Merriam (1897, p. 180) found two females, taken June 28, 1891, at Fort Tejon, to contain "large embryos, nearly ready for birth."

While carrying on field work at Snelling, Merced County, May 27, 1915, Mr. Charles L. Camp came upon a troop of youngsters who were setting up a wire net under the gable end of a church building with the intent of ridding the place of a colony of bats the presence of which had caused annoyance to the pastor and his congregation. Mr. Camp writes (MS):

> I could plainly hear the bats squeaking (6:30 P.M.) inside the wall, at a distance of fifty feet from the building. About 7:30 the first bat came out, missed the net and flew away. It was quickly followed by another which circled, lit on the side of the building, and was shot. No more bats appeared for ten minutes and then they began to drop into the net at the rate of about four a minute, coming faster toward the last, when twenty-one were found in the trap. After the net was taken down at 8 o'clock, many more bats, all apparently of the same species (*Antrozous pacificus*) flew out of the building, circled about in the trees and flew away. The bats caught (22 in all) were females, each containing one or two embryos, except one which was a male with testes small or medium.

Bees and red-shafted flickers were living in the same building with the bats.

With one exception all dates of occurrence known to me are between March 27 and October 19. In the collection at Stanford University are two females secured by C. J. Pierson, January 1, 1895, at Carmel Mission, Monterey County. The Pacific pallid bat is probably to a partial extent migratory.

Family MOLOSSIDAE

Foot and leg short and stout. Ears variable, sometimes joined across forehead; tragus much reduced; antitragus usually very large; anterior border of auricle never with basal lobe. Muzzle obliquely truncate, usually sprinkled with short modified hairs having spoon-shaped tips; nostrils simple, usually opening on a special pad, the upper surface of which is often set with fine horny excrescences. Wing narrow; fifth metacarpal only about two-thirds as long as third; membranes thick and leathery. Uropatagium short; tail projecting conspicuously beyond its free edge. Miller (1907, p. 243) recognizes ten genera, only two of which have been found to occur in the western hemisphere north of southern Mexico.

Genus **Nyctinomus** Geoffroy

Ears large and rounded, rising from middle point of forehead, extending distinctly beyond extremity of muzzle when laid forward; anterior border of conch with 6 to 12 horny excrescences; keel well developed; tragus small, flattened, squarely truncate above; antitragus variable in form, sometimes low and indistinct. Muzzle pad well developed and sharply outlined, its upper margin thickly set with horny points like those on anterior margin of ear; a line of similar points extends downward across middle of pad between nostrils. Upper lip full and wrinkled, rather thickly sprinkled with stiffened spoon-shaped hairs; feet stout; wings narrow (Miller, 1907, p. 251).

Nyctinomus depressus Ward

Tacubaya Free-tailed Bat

Nyctinomus depressus Ward (1891, pp. 747–750, 2 figs.). Original description; type locality, Tacubaya, Federal District, Mexico.

Nyctinomus macrotis nevadensis H. Allen (1894, pp. 171–174, pls. 34–35). Description of supposed new form, from "Nevada and California."

Nyctinomus nevadensis, J. A. Allen (1894, pp. 326–328). Description of adult male; type fixed.

Nyctinomus nevadensis, Miller and Rehn (1901, p. 273). Type locality.

Nyctinomus macrotis nevadensis, Elliot (1901, p. 417). Description; distribution.

Nyctinomus nevadensis, Miller (1902, p. 250). Declared to be a synonym of *Nyctinomops depressus.*

Nyctinomops depressus, Elliot (1904*b*, p. 627). Description; distribution.

Nyctinomops depressus, Stephens (1906, p. 275). Description; distribution.

Nyctinomus macrotis nevadensis, Lyon and Osgood (1909, p. 280). Nature and location of type.

Nyctinomus depressus, J. Grinnell (1913*b*, p. 283). Nature of occurrence in California.

Diagnosis.—Size large; total length 131 millimeters, free portion of tail, 33; muzzle not "concave" between ears; color, above, burnt umber; below, Prout's brown.

Description: Head.—Inner edge of ear evenly convex when flattened out; forward interior margin reflexed over a deep depression at upper extremity of keel, forming a sort of pocket; outer margin bilobate; the lower lobe arising from a short straight base coming up from antitragus, upper lobe continuous with tip and inner edge; keel large, strongly reflexed at angle near base, and extending slightly exterior to antitragus. Tragus straight on inner and upper margins; outer margin formed by two slightly concave lines producing by their juncture a slight lobe at center of this margin. Conch with seven diagonally transverse flutings, appearing as furrows on upper surface, and as ridges on lower surface, the posterior one being but very slightly indicated. On outer surface of conch, and passing through centers of these flutings at right angles to them, is a slight ridge formed by a doubling of the skin. The peculiar depressed angle formed by the juncture of the two lobes of the external margin of the conch gives the ears of this species a peculiar drooping appearance that suggested the specific name *depressus.* Nostrils circular, opening forwards, outwards, and very slightly downwards. A prominent subcircular swelling between eye and nostril and slightly below the line connecting them. Side of face with five flutings extending to lip, and a deep furrow under eye. Face and chin nearly naked.

Limbs and Membranes.—On upper surface of antebrachial membrane, a line of very short hairs, so fine as scarcely to be perceptible when wet, borders humerus and radius. On upper surface of the wing membrane, short lines of hairs border the radius, except at the extreme elbow, and occupy the angle formed by juncture of fourth and fifth metacarpals. Both upper and lower surfaces of wing membrane covered with hairs to a line extending from proximal third of humerus to middle of femur. Interfemoral membrane covered for three or four millimeters below the femora on upper surface, but naked on lower. A well-developed callosity at base of first phalanx of thumb.

Color.—Above, burnt umber; below, Prout's brown; bases of hairs on both surfaces white. Membranes and ears (in alcoholic specimen) nearly concolor with under surface of body. Wing membranes, from inner surface of distal end of tibia and from calcar, indefinitely edged with yellowish white, this color better defined in centers of interdigital spaces and in center of space between fifth finger and tibia. Outer edges of first and fifth toes closely fringed with short curved white hairs; on fifth toe, dorsal to this outer fringe, is a row of less numerous curved hairs, exceeding others about three times in length. From upper surface of base of each claw spring three or four long curved hairs, about 8 millimeters in length of chord.

Teeth.—Dental formula: $i\frac{1-1}{2-2}$, $c\frac{1-1}{1-1}$, $pm\frac{2-2}{2-2}$, $m\frac{3-3}{3-3}=30$. Upper incisors semi-conical, parallel, and separated by a space of 1 millimeter. Lower incisors bifid, crowded; the middle pair in a straight line; the outer ones start from near centers of inner surfaces of middle pair and diverge at an angle of 45 degrees from them. Canines long, with distinct, unbroken cingula, somewhat dilated on posterior internal part of lower one, but not forming a true cusp. Upper canines curved backwards, sabre-shaped, passing 1.5 millimeters below gums of lower teeth when mouth is closed, lower pair fitting into sockets between upper incisors and canines. First upper and lower premolars much smaller than second ones. Second upper premolars decidedly longer than molars, with very acute outer cusps; internal cusps not particularly developed.

Measurements (in millimeters from alcoholic specimen).—Length of head and body, from tip of nose to base of tail, 79; length of tail, 52; length of tail beyond interfemoral membrane, 33; length of head, 31; length of ear, from notch between antitragus and conch to anterior point of margin, 25; length of antitragus, 7; height of antitragus, 4.5; width of tragus at top, 2.5; ears united at base for, 3.5; length of forearm, 60; length of thumb, not including metacarpal, 8; extent of outstretched wings, 357; length of tibia, 18; length of foot, 13; length of calcaneum (poorly defined), about 16.

The above description is compiled from Ward's (1891, pp. 747–750, original description). A comparison of this description with those given by H. Allen (1894, p. 171) and J. A. Allen (1894, p. 326) shows agreement in general characters. Ward, however, notes the absence of a gular pouch, while J. A. Allen indicates the presence of a well-marked gular pouch.

Synonymy and History.—This bat was described by Ward (1891, pp. 747–750) from a single adult male specimen, taken within the museum building at Tacubaya, Federal District, Mexico. In 1893, H. Allen (1894, pp. 171–174, pls. 34, 35), apparently unaware of Ward's description, redescribed the species as *Nyctinomus macrotis* nevadensis, from two immature specimens in the United States National Museum. J. A. Allen (1894, pp. 326–328), upon examination of a fully adult male, raised the supposed form to full specific rank, and fixed typeship upon a specimen (no. $\frac{15178}{36569}$, U. S. Nation. Mus.) from "California." Miller (1902, p. 250) placed the name *nevadensis* of H. Allen under the synonymy of *Nyctinomus depressus* Ward.

Distribution.—This bat has been recorded from Mexico City, Mexico, and within the United States from Arizona, Nevada, Colorado, Iowa, and California, there being but one record for each of the states named, except for Iowa, where two specimens have been secured (Cory, 1912, p. 477; Gabrielson, 1916, p. 86).

In the cases of the Nevada and California examples of *Nyctinomus depressus* the exact localities of capture are not known. The Colorado example was taken at Grand Junction (altitude about 5000 feet) (Warren, 1910, p. 286); and the Arizona specimen when secured was flying over a small meadow in the Chiricahua Mountains, at an altitude of about 9500 feet (J. A. Allen, 1895, pp. 245–246). Mexico

City, where the type specimen was taken, has an altitude of over 7000 feet.

Natural History.—Nothing is known under this head.

Nyctinomus femorosaccus Merriam

Pocketed Bat

Nyctinomus femorosaccus Merriam (1889*a*, p. 23). Original description; type locality, Agua Caliente [=Palm Springs, Riverside County], California.

Nyctinomus femorosaccus, Bryant (1891*a*, p. 359). Nominal.

Nyctinomus femorosaccus, Bryant (1892, p. 220). Nominal.

Nyctinomus femorosaccus, Elliot (1901, pp. 417–418). Description.

Nyctinomus femorosaccus, Miller and Rehn (1901, p. 272). Type locality.

Nyctinomus femorosaccus, Elliot (1904*a*, p. 321). Specimen recorded from Palm Cañon, Colorado Desert.

Nyctinomus femorosaccus, Elliot (1904*b*, p. 626). Description.

Nyctinomops femorosaccus, Stephens (1906, p. 274). Description; type locality.

Nyctinomops femorosaccus, Elliot (1907, p. 523). Repeated record.

Nyctinomus femorosaccus, Miller (1912, p. 69). Nominal.

Nyctinomus femorosaccus, J. Grinnell (1913*b*, p. 282). Range in California.

Diagnosis.—Size medium (total length 103 millimeters); tail more than half exserted; a fold of membrane extends from inner third of femur to middle of tibia, forming a pocket at thigh; ears connected at bases; color dull brown.

Description.—Merriam (1889*a*, p. 23) gives the following description of the type specimen of the pocketed bat:

Measurements [in millimeters] (from the alcoholic specimen).—Total length, 103; head and body, 60; tail, 41; exserted part of tail, 23; head, 23; ear from crown, 14; ear from base of antitragus, 20; tragus, 1; humerus, 28; forearm, 47; third finger: metacarpal, 45; first phalanx, 20; second phalanx, 19; fifth finger, 44.

General Characters.—Incisors $\frac{1-1}{2-2}$. Lower incisors bifid and crowded; first upper premolar small, but well developed; second very large, with a large and high antero-internal cusp. Ears thick, united by bases of inner margins 4.5 mm. from end of nose; ear keel greatly developed, with a large lobe on its lower third; antitragus higher than long, convex anteriorly, slightly concave posteriorly, and separated by a deep notch; tragus subquadrate, hidden behind the large antitragus, its outer angle projecting upward in the form of a small pointed lobule; upper margin of ear conch with two minute horny projections, not symmetrical on the two sides. Tail more than half exserted. Gular sac present (opening on right side of median line). There is a curious fold of membrane stretching from the inner third of the femur to the middle of the tibia, forming a deep pocket between it and the interfemoral membrane. The wing membrane is attached to the leg at the same point (immediately below the middle of the tibia), so that there are three folds of membrane here. The fur extends out on the wing membrane, above and beneath, as far as a line drawn from the middle of the humerus to the junction of the middle and outer thirds of the femur. Color, dull brown.

A skull of the pocketed bat (U. S. Nation. Mus. $\frac{36038}{20922}$), from Fort Huachuca, Arizona, which the present writer has examined, measures, in millimeters: total length, 19.2; zygomatic breadth, 10.1; breadth of brain-case, 10.0; interorbital constriction, 3.7.

Distribution.—The type specimen was collected by F. Stephens at Agua Caliente [=Palm Springs], Colorado Desert, Riverside County, California, March 27, 1885. The only other Californian record of this bat, of which the writer is aware, is that by Elliot (1904*a*, p. 321), who reports the finding by Edmund Heller of a mummified specimen impaled on a mesquite bush in Palm Cañon, near Palm Springs. The bush overhung a pool of water where bats came to drink. (See map, text-fig. O.)

Natural History.—Nothing is known of the habits of the pocketed bat.

Nyctinomus mexicanus (Saussure)

Mexican Free-tailed Bat

M[*olossus*]. *mexicanus* Saussure (1860, pp. 283–285, pl. 15, figs. 2, 2*a*). Original description; from Ameca, Jalisco, Mexico.

Nyctinomus nasutus, H. Allen (1864, pp. 7–10). Description; nomenclature; record of specimen from Fort Yuma.

Nyctinomus nasutus, Cooper (1868, p. 5). Distribution.

Nyctinomus nasutus, Cooper (*in* Cronise, 1868, p. 442), part. Occurrence in California.

Nyctinomus nasutus, Coues and Yarrow (1875, pp. 81–82), part. Distribution.

Nyctinomus brasiliensis, Dobson (1878, pp. 437–439, pl. 32, fig. 8). Description; general range.

Nyctinomus brasiliensis, True (1885, p. 603). Range.

Nyctinomus mohavensis, Bryant (1891*a*, p. 359). Distribution.

Nyctinomus mohavensis, Bryant (1892, p. 220). Nominal.

Nyctinomus brasiliensis, H. Allen (1894, pp. 163–171, pls. 32–33). Description; nomenclature; distribution.

Nyctinomus brasiliensis californicus H. Allen (1894, p. 166, pl. 32, fig. 5). Description of a ''variety'' from ''California.'' The only California locality mentioned under *N. brasiliensis* is Fort Yuma.

Nyctinomus mohavensis, Stowell (1894, pp. 362–364). Description; distribution; habits of colony observed at San Jose, and occurrence at Pacific Grove.

Nyctinomus mohavensis, Elliot (1901, p. 418). Diagnosis.

Nyctinomus brasiliensis californicus, Miller and Rehn (1901, p. 272). Type locality.

Nyctinomus mohavensis, Miller and Rehn (1901, p. 273). Type locality.

Nyctinomus mexicanus, Elliot (1904*a*, pp. 320–321). Records of occurrence at Palm Springs and Fort Tejon.

Nyctinomus mexicanus, Elliot (1904*b*, pp. 629–630). Description; distribution.

Nyctinomus cynocephalus californicus, Stone (1904*b*, p. 587). Record of occurrence at Belmont.

Nyctinomops mohavensis, Stephens (1906, pp. 273–274). Description; distribution; habits.

Nyctinomus mexicanus, Elliot (1907, pp. 523–524). Record of specimens taken at Fort Tejon, Palm Springs, and San Jose.

Nyctinomus mexicanus, J. Grinnell (1913*b*, p. 283). Range in California.

Nyctinomus mexicanus, J. Grinnell (1914, p. 268). Occurrence along Colorado River.

Diagnosis.—Size medium (total length 90 to 103 millimeters); ears broad, apparently united at base, with a series of wart-like projections on anterior border; tragus small, flattened, squarely truncate above; exserted portion of tail about equal to that enclosed in membrane; general color, hair brown.

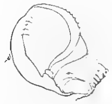

Fig. W. Side view of head of *Nyctinomus mexicanus* (drawn from specimen no. 18921), × 1.00, showing rounded ear, with wart-like projections on anterior margin of ear, short truncate tragus, deep furrow under eye, and perpendicular wrinkles in upper lip.

Description: Head.—Ears about as broad as long (text-fig. W), diverging from median line on forehead, and sometimes united at bases for a distance of 1 millimeter, although usually separate; "warts" on anterior margin of ear varying in number from five to eleven; a sinuous, sharply defined ridge arises from behind tragus and fades away toward anterior external portion of lobe; posterior surface of ear marked by five or six distinct transverse wrinkles; upper lip deeply crimped, forming perpendicular wrinkles. A deep furrow under eye.

Limbs and Membranes.—Wings relatively small and weak (as compared with those of other California bats which equal this species in size of body), slender; third metacarpal 1.7 length of fifth metacarpal. Wing attached to tibia on distal third. Feet stout with toes distended.

Pelage.—Dorsal surface of body well furred with short soft hairs averaging 3 or 4 millimeters in length. Hairs on ventral surface slightly longer and more closely set. On face and chin, in addition to shorter hairs, are scattered longer ones varying in length from 5 to 7 millimeters. Along edge of upper lip is a row of short, stiff, downward-directed hairs. Ears very scantily furred with minute hairs. Wings naked save for a narrow band of fur, continuous with that of body, which extends from middle of humerus along wing to proximal third of femur, on both dorsal and ventral surfaces, and for a fringe of hairs which extends along edge of post-calcarial lobe from its proximal end half way to its distal end. Outer edges of first and fifth toes closely fringed with short, curved, white hairs; on fifth toe, dorsal to this outer fringe, is a row of less numerous curved hairs, three times as long as those of the first row. From upper surface of base of each claw spring three or four long curved hairs 4 to 6 millimeters in length.

Color.—There is but little individual variation in color among the series of *Nyctinomus mexicanus* in the Museum of Vertebrate Zoology.

An example (no. 19006, ♀) from Concord, Contra Costa County, presents what is apparently the usual coloration of the species in California. This specimen is hair brown in color, slightly paler beneath, and with feet and membranes varying toward chaetura black. The hairs on the body are everywhere whitish at their bases. The long scattered hairs upon the face and chin are a dark hair brown, while the long curved hairs upon the dorsal surface of the claws are whitish.

Several specimens from Los Baños, Merced County, and the two examples from Painted Rock, Carrizo Plains, San Luis Obispo County, exhibit a yellowish suffusion, due perhaps to absorption of oil from the skin. Among thirty-one specimens from the vicinity of Fresno, Fresno County, a single example shows marked departure from the normal coloration. This individual is unusually sooty in appearance, fur and membranes being chaetura black in color.

Skull.—Brain-case slightly rounded; sagittal crest very feebly developed; lachrymal and supraorbital ridges low but distinct; dorsal surface of rostrum with a shallow longitudinal median concavity; zygomata slightly expanded at middle. Dorsal profile nearly straight, rising gradually from nose to top of brain-case; a depression between top of brain-case and occipital ridge. (See pl. 23, fig. 48; pl. 24, fig. 56).

Teeth.—Dental formula: i $\frac{1-1}{2-2}$ or $\frac{1-1}{3-3}$, c $\frac{1-1}{1-1}$, pm $\frac{2-2}{2-2}$, m $\frac{3-3}{3-3}$ = 30 or 32. Upper incisors simple, well developed, about half as high as canines, wide apart at base, strongly converging at tips, separated from canines by a space about equal to their greatest diameter, shaft narrowing both above and below slightly developed cingulum, its apex blunt. First and second lower incisors equal, their crowns in contact with each other and with cingulum of canine. In young specimens the crowns are bifid, with lobes rounded at the tip. In old specimens the crowns are squarely truncated; in some all trace of the notch is obliterated. Third incisor when present varies from a mere spicule to a slender well-formed tooth, bifid at crown, and three-fourths height of second incisor. In a series of thirty-seven skulls belonging to the Museum of Vertebrate Zoology sixteen were found to have three lower incisors on each side, eight to have two only, four to have two in the right mandibular ramus, and three in the left, and two to have three in the right ramus and two in the left. Seven of the skulls were found to have less than four lower incisors, the ones present being badly worn and broken.

Stowell (1894, p. 363) found that of forty-five specimens examined twenty-four possessed six lower incisors, nine had five, and twelve had four. He remarks:

> The outer incisor when present is very small, and so crowded forward as to occupy a precarious position in front of the canine, a fact which may account for its absence in so many specimens. In by far the majority, the incisors are distinctly bilobate and the lobes have well-rounded tips; but in some specimens the tips have become more or less worn, and in a few individuals this process has proceeded so far that the upper edges of the teeth are truncate, with scarcely a trace of the median notch. In the specimens examined we have noticed that most of those with perfectly truncate incisors have the latter also reduced in number. This probably indicates that both conditions are dependent upon age.

While most of the skulls in the Museum of Vertebrate Zoology lacking the third incisor, show badly worn teeth, yet two with unworn teeth show no trace of the third incisor, indicating that the absence of this tooth is sometimes a matter of individual variation, as well as of age.

Canines strong and well developed, with distinct cingula. First upper premolar minute; second well-developed. First lower premolar about half as high as second, but with base nearly as large. Molars normal.

Measurements.—Average and extreme measurements in millimeters of twenty examples of *N. mexicanus* in the Museum of Vertebrate Zoology are as follows: ten males: total length, 95.4 (90.0–99.0); tail vertebrae, 34.6 (32.0–38.0); tibia, 12.3 (11.6–13.0); foot, 10.1 (8.0–12.0); forearm, 41.4 (40.7–44.0); greatest length of cranium, 17.1 (16.6–17.5); zygomatic breadth, 10.0 (9.6–10.5); mastoid breadth, 9.4 (9.3–9.7); interorbital constriction, 3.9 (3.9–4.2); ten females: total length, 96.2 (91.0–103.0); tail vertebrae, 35.5 (31.0–40.0); tibia, 12.2 (11.5–13.8); foot, 9.3 (8.0–11.0); forearm, 41.2 (39.0–43.0); greatest length of cranium, 16.9 (16.7–17.4); zygomatic breath, 9.8 (9.6–10.0); mastoid breadth, 9.2 (9.1–9.5); interorbital constriction, 3.9 (3.7–4.2).

Synonymy and History.—*Nyctinomus mexicanus* was described under the name *Molossus mexicanus* by Saussure (1860, p. 283) from material obtained at Ameca, Jalisco, Mexico (Miller, 1912, p. 70). Merriam (1889*b*, p. 25) described a bat which appears to be identical with *N. mexicanus,* from Fort Mohave, Mohave County, Arizona, under the name *Nyctinomus mohavensis.* Harrison Allen (1894, p. 166) described the same species from California under the name *Nyctinomus brasiliensis californicus.* The California bat, however, appears to be distinct from *brasiliensis* of South America. The writer has examined the five bats from Belmont, California, recorded by Rehn (*in* Stone, 1904*b*, p. 587) under the name *Nyctinomus cynocephalus californicus* and finds them distinct from true *cynocephalus* and in no way different from examples of *mexicanus* from elsewhere in California.

Distribution.—*Nyctinomus mexicanus* has been recorded from the volcano Popocatepetl, Mexico, northward through the United States to Newcastle, Garfield County, Colorado (Warren, 1910, p. 286), and eastward from the Pacific to the middle of Texas where, according to Bailey (1905, p. 215) "its eastern limit of range, so far as known, agrees closely with the eastern limits of mesquite." In California the species is abundant throughout the Upper and Lower Sonoran zones, from the southern border of the state northward at least to Marysville Buttes, Sutter County. Throughout the central valleys

MEASUREMENTS IN MILLIMETERS OF TWENTY EXAMPLES OF NYCTINOMUS MEXICANUS (SAUSSURE), FROM CALIFORNIA

Mus. no.	Sex	Locality	Total length	Tail vertebrae	Tibia	Foot	Forearm	Greatest length of cranium	Zygomatic breadth	Mastoid breadth	Interorbital constriction
3872	♂	Palo Alto, Santa Clara Co.	90.0	34.0	13.0	11.0	41.0	17.2	10.0	9.5	4.0
3875	♂	Palo Alto, Santa Clara Co.	91.0	35.0	13.0	11.0	41.0	16.9	9.6	9.4	4.0
6701	♂	San Francisquito Cañon, Los Angeles Co.	93.0	33.0	13.0	8.0	41.0	17.3	9.8	9.3	3.9
5135	♂	Santa Monica, Los Angeles Co.	95.0	35.0	12.0	8.0	41.3	17.2	10.0	9.6	3.9
5127	♂	Pasadena, Los Angeles Co.	97.0	37.0	......	8.0	44.0	16.6	10.0	9.5	3.9
8317	♂	Sweetwater Dam, San Diego Co.	99.0	38.0	......	11.0	41.0	16.8	10.0	9.4	4.0
14656	♂	Los Baños, Merced Co.	95.0	32.0	12.0	12.0	40.7	16.8	10.2	9.5	4.0
14657	♂	Los Baños, Merced Co.	99.0	35.0	12.0	11.0	41.0	17.5	10.5	9.7	4.0
6700	♂	Glendora, Los Angeles Co.	98.0	32.0	11.6	9.0	41.3	17.5	10.0	9.5	4.2
14655	♂	Los Baños, Merced Co.	97.0	35.0	12.0	12.0	41.9	17.3	10.3	9.5	4.0
12670	♀	Fresno, Fresno Co.	91.0	31.0	11.5	9.5	40.5	17.0	9.6	9.1	3.7
5129	♀	Pasadena, Los Angeles Co.	92.0	34.0	11.5	8.0	39.0	16.7	9.6	9.2	3.7
5130	♀	Pasadena, Los Angeles Co.	94.0	35.0	12.0	9.0	40.0	16.8	9.9	9.4	4.0
5133	♀	Pasadena, Los Angeles Co.	95.0	35.0	......	8.0	41.4	17.0	......	9.4	4.0
5127	♀	Pasadena, Los Angeles Co.	97.0	37.0	......	8.0	42.5	16.8	10.0	9.2	4.0
14665	♀	Carrizo Plains, San Luis Obispo Co.	99.0	33.0	13.8	11.0	43.0	17.4	10.0	9.5	4.2
22101	♀	Coulterville, Mariposa Co.	103.0	40.0	......	9.0	42.2	......	9.8	....	3.8
22100	♀	Coulterville, Mariposa Co.	103.0	40.0	......	9.0	41.5	17.0	10.0	9.2	3.9
14666	♀	Carrizo Plains, San Luis Obispo Co.	94.0	31.0	12.6	11.0	40.0	16.7	9.7	9.5	4.2
18501	♀	Marysville Buttes, Sutter Co.	94.0	39.0	......	11.0	42.2	......	......	....	....

of the state it is one of the most abundant bats, occurring in great colonies where conditions are favorable. (See map, text-fig. X.)

Specimens Examined.—The writer has examined 217 specimens of *Nyctinomus mexicanus* from the following localities in California:

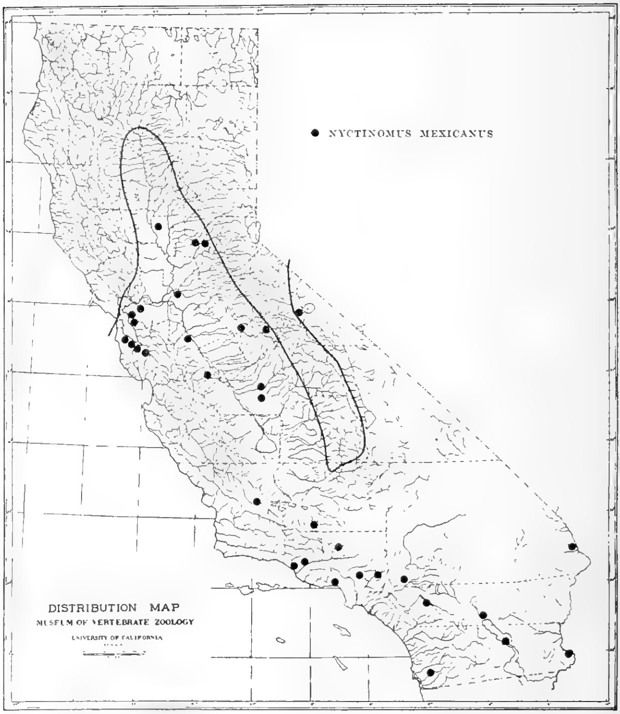

Fig. X. Map showing stations of occurrence in California of *Nyctinomus mexicanus*, as established by specimens examined by the author.

San Diego County: Sweetwater Dam, 1; Imperial County: 8 miles east of Picacho, 1; Echo Island, Salton Sea, 1; Riverside County: Mecca, 1; San Jacinto, 10 (Stanford Univ.); San Bernardino County: Chemehuevis Valley, 1; San Bernardino, 2; Los Angeles County: Glendora, 1; Pasadena, 11; San Francisquito Cañon, 1; Santa Monica, 1; Ventura County: Santa Paula, 1 (Stanford Univ.); Ventura, 8; Kern County: Fort Tejon, 1; San Luis Obispo County: Painted Rock, Carrizo Plains, 2; Fresno County: Fresno, 29; Lane Bridge, 10 miles north Fresno, 2; Mariposa County: El Portal, 1; Coulterville, 2; Mono County: Walker Lake, 1; Merced County: Los Baños, 18; Stanislaus County: Grayson, 1; Santa Clara County: Menlo Park, 7; Palo Alto, 13 (Stanford Univ., 5; Mus. Vert. Zool., 8); Stanford University, 1 (Calif. Acad.); San Jose, 52 (Stanford Univ.); San Mateo County: Belmont, 5 (Acad. Nat. Sci. Phila.); Alameda County: Berkeley, 2 (U. C. Dept. Zool.); Alameda, 1; San Joaquin County: Tracy Lake, 6 miles southwest Galt, 1; Contra Costa County: Concord, 24; Eldorado County: Limekiln, 12; Placer County: Auburn, 1; Sutter County: Marysville Buttes, 3 miles southwest Sutter, 1.

Natural History.—This bat is gregarious and apparently prefers retreats in buildings rather than those afforded by nature. I know of no instance of the finding of these bats in natural haunts save where they had no choice of other quarters. On May 27, 1911, Swarth (MS) found a cluster of these bats in company with a large number of *Antrozous pacificus* in a crevice extending upward from a hollow at the base of Painted Rock, Carrizo Plains, San Luis Obispo County. When a buggy whip was thrust up among them some of the bats crawled farther up into the crevice, while about fifteen or twenty tumbled out and flew about the rock seeking other shelter. At Glendora, Los Angeles County, a raid upon a colony of *Antrozous* occupying the spaces under the eaves of a barn loft resulted in the capture of ten *Antrozous* and a single male *Nyctinomus mexicanus*. More of the latter species may have been present as many of the bats disturbed eluded capture and escaped into the open air. Stowell (1894, pp. 362–364) records the finding of large numbers of these bats behind the iron window shutters of the courthouse in San Jose. On February 27, the leaves of one of these shutters were opened and the bats were found thickly clustered in the darker recesses. The bats made little effort to escape and about seventy specimens were secured. These consisted of males and females in about equal numbers. The window from which these bats were secured was on the west side of the building. On March 3, of the same year, thirty-two specimens were taken from another west window and these bats also consisted of an equal proportion of the two sexes. An examination of four different windows on the east side of the building resulted in the capture of thirty-five specimens, all females. W. P. Taylor

(MS), when encamped in April, 1912, near Marysville Buttes, Sutter County, noted bats of this species flying down the cañon each evening. They appeared shortly after 6:45 P.M. C. H. Richardson (MS) took six male *N. mexicanus* from spaces between the sheathing and shakes on a barn beside a slough near Los Baños, Merced County, on March 25, 1911. He writes: "This was evidently an old roost, for the dung lay thick upon the floor. There were many bats present, to judge from the amount of squeaking and the odor."

Several specimens of this bat have been sent to the Museum of Vertebrate Zoology from the attic of a schoolhouse at Fresno.

Heller (*in* Elliot, 1904*a*, p. 320) found *Nyctinomus mexicanus* common in the spring of 1902 in Palm Cañon, near Palm Springs, Riverside County. He also found several hundred living in the garret of one of the old buildings at Fort Tejon, Kern County.

Specimens secured during November and December from the attic of a blacksmith shop at Concord, Contra Costa County, and sent to the Museum of Vertebrate Zoology, were excessively fat. The males examined had very small testes. Specimens secured from the same colony January 31 were very thin. In one of the males examined the testes were slightly enlarged, indicating the possibility of spring mating in this species. The stomachs of four specimens were crammed with the remains of insects, flies and small beetles, too finely triturated for identification. I do not think that these bats had hibernated but that the loss of fat was due to the scarcity of food, caused by the frosty weather of December and January.

Along the Colorado River between Needles and Yuma, in the spring of 1910, Museum collectors found the species not uncommon. In the neighborhood of Mecca, Riverside County, the species was found during the spring of 1908, and one specimen was collected from a colony found in a cave on Echo Island in Salton Sea.

On the evening of January 1, 1915, J. Grinnell (MS) noted several bats flying at El Portal, Mariposa County, 2000 feet altitude. One of the two examples shot proved to be *Nyctinomus mexicanus*. This specimen, a female, weighed 11.5 grams. Specimens and records at hand establish the presence of the Mexican free-tailed bat in the same general areas of the state throughout the year. It is therefore safe to infer that this species is but slightly or not at all migratory.

On October 27, 1916, J. R. Pemberton and J. Grinnell investigated a colony of bats (pl. 14, fig. 2) occupying the attic of a brick house at San Bernardino, the home of R. B. Herron. Dr. Grinnell records (MS) his observations as follows:

I found just one species, *Nyctinomus mexicanus*, though Mr. Herron declares there are at least three kinds present, at different seasons of the year. I went all through the attic and all I saw distinctly, flying or in different "colonies," were of the above species. There are now at least 1000 bats, clinging together in patches in the peak of the roof, or crowded into crevices between the ridgepole and the shingles. Along the floor is a longitudinal heap of guano 6 inches to 1½ feet high. Herron says that he has taken out five grain sacks of the guano at one time, and used it about the garden as fertilizer. The bats "chuckle" continually, a subdued chorus of talking sounds. There are very few of the shrill squeaks. The animals crawl, back upwards, as far as they can get. The lower ones crowd against the upper ones, the latter squeezing farther into the crevices, the whole mass in continual agitation. When thoroughly disturbed many took flight, and the fluttering wings and occasional collisions with me (or attempts to alight) gave a weird impression.

Mr. Herron thinks these bats migrate—they seem to be entirely gone for three or four months, in cold weather, and then all at once they come in. "In summer time there are three kinds, a big broad-winged one, a little narrow-winged one, and this one."

Sun sets at 4:57. Perfectly clear weather. First bat out at 5.04. At 5:07, 27 had come out. At 5:10, 95 more had come out. At 5:15, 120 more had come out. At 5:30, when it had gotten too dark for me to count longer, 1367 more had come out. Total counted, 1609.

Although there were three gable ends, each with a small slatted ventilator window, all the bats came out of the west-facing one. Mr. Herron says the first usually comes out just before the sun sets, and all are out in about half an hour. He thinks there are as many as 5000 there in midsummer. Just before they came out, in little squads of 10 to 50, I heard a low chuckling chorus at the grating; then the crowd began to pour out.

Two female Mexican free-tailed bats taken by Ferris and Storer at Coulterville, Mariposa County, June 7, 1915, each contained one large embryo.

Twelve specimens of *Nyctinomus mexicanus* secured by Mr. Joseph Dixon at Limekiln, Eldorado County, between August 3 and 6, 1916, were females and varied in weight from 11 to 15 grams. Dixon states (MS) that the mammary glands of these bats were full of milk, although the glands of adult individuals of *Eptesicus* and *Myotis* taken at the same time were undeveloped.

Genus **Eumops** Miller

Ears very large, rounded or squarish in outline, joined across forehead, usually extending slightly beyond nostril when laid forward, the anterior margin without horny processes; antitragus distinct but not thickened, keel greatly developed, flattened and expanded at edge; tragus small, flat, its upper edge truncate or rounded. Lips full and expanded, not conspicuously wrinkled. Muzzle pad well developed, deeply emarginate above, its upper edge and median ridge with minute horny processes and small spoon hairs. Wings, feet and tail as given for the family.

Length of skull slightly more than twice its greatest width; rostrum more than half length of brain-case; angle between rostrum and brain-case very slight, in fact whole dorsal profile nearly straight; sagittal crest but slightly developed; zygomata not expanded at middle; palate slightly arched.

Dental formula: i $\frac{1-1}{2-2}$, c $\frac{1-1}{1-1}$, pm $\frac{2-2}{2-2}$ or $\frac{1-1}{2-2}$, m $\frac{3-3}{3-3}$ = 30 or 28. Upper incisors long and slender, nearly one-half height of upper canines and diverging slightly near their tips. Lower incisors tall, slender, and crowded in a semicircular row beneath projecting cingula of canines; crowns of lower incisors bifid and one-third wider than columnar shafts. Canines large and robust (see pl. 20); height of upper canine about one-third more than antero-posterior diameter at cingulum; anterior face slightly grooved, and inner face somewhat concave; lower canines slightly smaller than upper, but similarly proportioned. First upper premolar, if present at all, minute and closely crowded between canine and second premolar. Posterior upper premolar with crown area more than half that of first molar and exceeding it in height. Lower premolars with crowns about as long as broad; that of second slightly exceeding that of first in height. Molars not peculiar in form; crowns of lower exceed those of upper in height. In *Nyctinomus* the upper incisors are wide apart at their bases, with converging tips, whereas in *Eumops* the upper incisors are in contact at their bases, diverging toward the tips.

One species of *Eumops* has been recorded from California.

Eumops californicus (Merriam)

California Mastiff Bat

Molossus californicus Merriam (1890, pp. 31–32). Original description; type locality, Alhambra, Los Angeles County, California.

Molossus californicus, Bryant (1891*a*, p. 359). Nominal.

Molossus californicus, J. A. Allen (1891*a*, p. 198). Distribution; relationships.

Promops perotis californicus, H. Allen (1894, pp. 175–182, pls. 36–38). Description.

Promops californicus, Elliot (1901, pp. 422–423, fig. 94). Description; distribution.

Promops californicus, Miller and Rehn (1901, p. 271). Type locality.

Promops californicus, Elliot (1905, p. 498). Geographic distribution.

Promops californicus, Stephens (1906, p. 275). Description; distribution.

Eumops californicus, Miller (1906, p. 85). Description (as type species of new genus).

Eumops californicus, Miller (1912, p. 71). Type locality.

Eumops californicus, J. Grinnell (1913*b*, p. 283). Range in California.

Diagnosis.—Size large (total length 157 to 184 millimeters); ears very broad, united above nostrils, directed forwards rather than upwards; tail exserted far beyond edge of interfemoral membrane; upper incisors in contact at their bases, diverging toward tips. (See pl. 19, figs. 19–20; pl. 20, figs. 21–23.)

Description.—Head elongate (length of head, in alcoholic specimen, 42 millimeters, greatest width, 20); muzzle pad prominent, deeply emarginated above, its upper edge and median ridge with minute horny processes and small spoon-hairs; nostrils large, directed downward and outward; eyes placed far back on sides of head (center of eye, in alcoholic specimen, 21 millimeters from tip of muzzle), and almost concealed by the drooping anterior border of the auricle. In front of each eye is a prominent glandular swelling. Ears large, directed outward and forward, joined in median line, and so large as to entirely conceal face and muzzle from an observer when viewing the bat from the dorsal side. Ear conch, or auricle, broadly convex anteriorly and posteriorly, slightly convex on top (pl. 20, fig. 21). Tragus small, truncate (in alcoholic specimen 3.5 millimeters in height at anterior edge and 3 millimeters in breadth at top), and nearly concealed by the semi-oval antitragus, which is (in alcoholic specimen) 10.5 millimeters in length and 7 in greatest height; antitragus separated posteriorly from conch by a deep notch. Ears haired along margin, but greater portion of keel, both externally and internally, naked. Folds of ears directly above nostrils heavily haired on both upper and lower surfaces. Upper lip with a thick fringe of downward-directed hairs.

Limbs and Membranes.—Wings long and slender (pl. 19); fifth metacarpal scarcely more than half length of third. Dorsal surface of wing membrane, as well as interfemoral membrane, furred to a distance of about 12 millimeters from body. A small patch of hairs on dorsal surface of antebrachial membrane, this patch extending inward from edge of radius, except at bottom of angle formed by junction of radius with humerus; another group of hairs extending along distal three-fourths of posterior edge of forearm, widening and occupying angle between forearm and fourth metacarpal; a third small group of hairs at distal end of third metacarpal. A small patch of fur on ventral surface of antebrachial membrane, occupying angle between anterior edge of membrane and proximal half of humerus; a line of fur extends from this patch across humerus and along its posterior edge and unites with a small patch on lateral membrane immediately posterior to distal end of humerus. Interfemoral membrane not haired, except for a narrow border along proximal margin of its dorsal surface, and a few scattering hairs along edge of post-calcarial lobe. Legs and feet short and stout; feet only twice as long as wide.

Pelage.—Fur long and soft, denser and shorter on abdomen than elsewhere, varying in length from 5 to 10 millimeters.

Color.—Membranes deep hair brown; fur a lighter tone of same color, slightly paler on ventral surface; bases of hairs everywhere whitish for a distance of from one-half to three-fourths their length.

Skull and Teeth.—As given for the genus (see p. 370).

Measurements.—Average and extreme measurements in millimeters of ten specimens of the mastiff bat in the Museum of Vertebrate Zoology are as follows: total length, 167.1 (extremes, 157.0–184.0); tail vertebrae, 59.7 (52.0–70.0); tibia, 22.1 (21.0–23.3); foot, 16.8 (13.0–19.0); forearm, 72.0 (69.0–74.5); greatest length of cranium, 31.0 (30.0–32.0). Five specimens, measured fresh, showed stretch of wings, tip-to-tip, of 526 millimeters (515–535) [= 20–21 inches].

Measurements in Millimeters of Ten Examples of Eumops californicus (Merriam), from California

Mus. no.	Sex	Total length	Tail vertebrae	Tibia	Foot	Forearm	Greatest length of cranium	Zygomatic breadth	Breadth of brain-case	Interorbital constriction
4326[1]	♂	165.0	63.0	......	15.0	73.5	32.0	17.8	15.3	5.0
5242[2]	♂	157.0	55.0	22.0	18.0	69.4	31.9	17.5	14.8	5.3
16597[3]	♂	184.0	70.0	23.0	17.0	72.0	......	......	......	....
4327[1]	♀	157.0	61.5	......	14.0	71.0	31.2	17.6	14.7	4.9
6946[1]	♀	167.0	55.0	23.3	13.0	69.0	30.0	17.0	14.8	5.0
19021[2]	♀	171.0	59.0	21.0	19.0	71.0	30.8	17.4	15.1	5.1
19022[2]	♀	166.0	52.0	23.0	17.0	74.5	30.6	17.0	14.6	4.6
19191[2]	♀	173.0	63.0	21.1	18.0	72.0	31.0	18.0	15.1	5.1
19192[2]	♀	166.0	61.5	21.4	18.5	73.4	30.0	18.2	15.3	5.3
19283[2]	♀	165.0	57.0	......	19.0	74.5	31.7	18.0	15.2	5.2

[1] From Pasadena, Los Angeles County.
[2] From Sierra Madre, Los Angeles County.
[3] From Colton, San Bernardino County.

Synonymy and History.—This bat was described by Merriam (1890, pp. 31–32) from a specimen taken at Alhambra, Los Angeles County, California, under the name *Molossus californicus.* Miller (1906, p. 85) made Merriam's *Molossus californicus* the type species of the new genus *Eumops,* distinguished from the nearly related genera *Molossus* and *Promops* by reason of its arched rather than domed palate and less well-developed sagittal crest.

Distribution.—Miller (1907, p. 256) figures the skull of a specimen taken at Tucson, Arizona, and Bailey (1905, p. 216) records the capture of a specimen of *E. californicus* at the bottom of Pump Cañon, near Langtry, Texas. J. Grinnell (1913*b*, p. 284) gives the range of this bat in California as follows: "Lower Sonoran zone of southern California; most numerous in the San Diegan district, but noted also on the Colorado Desert, and in the San Joaquin Valley, in Kern and Fresno counties (Mus. Vert. Zool.); northernmost station, Fresno." The basis of the latter record was two specimens seen in a taxidermist's shop in Fresno, and stated to have been caught in the courtyard of that city. (See map, text-fig. H.)

Specimens Examined.—The writer has examined 26 examples from the following localities in California: San Diego County: Dos Cabasas, 1 (U. S. Nation. Mus.); Otay, 1 (Stanford Univ.); Riverside County: Mecca, 1; San Bernardino County: Colton, 1; Los Angeles County:

Los Angeles, 2 (U. S. Biol. Surv., 1; U. S. Nation. Mus., 1); Pasadena, 6; Sierra Madre, 9; Kern County: Sumner, 1; Buttonwillow, 1 (Calif. Acad. Sci.); Bakersfield, 1 (Univ. Calif. Dept. Zool.); Tulare County: Traver, 1 (Stanford Univ.); Fresno County: Fresno, 1.

Natural History.—The type specimen of *E. californicus* was found by E. C. Thurber on a December evening on a ledge over a door. Merriam (1890, p. 31) says: "Two others were caught during the same month (December, 1889), and both in similar situations. Mr. Thurber says of one of them: 'It was hanging from the ledge of a window, swinging back and forth and knocking against the window as if to attract attention. All were caught about 8 or 9 o'clock in the evening.'"

On October 1, 1916, Adrey Borell, of Fresno, sent to the Museum of Vertebrate Zoology a live mastiff bat which he had just found hanging on the inside of a window-sill in a school building in Fresno. H. C. Ohl (MS) found a mastiff bat in a railroad round-house at Mendota, Fresno County, in December, 1911. The last named locality constitutes the northwesternmost record station to date.

Stephens (1906, p. 275) records the capture of a specimen behind a sign board and another in a tunnel, and adds that all dates known to him are in winter.

On or about October 1, 1907, a specimen of *E. californicus* (now no. 23391, Mus. Vert. Zool.) was found clinging to the side of a house at Mecca, Riverside County.

On March 8, 1909, W. B. Donnell discovered five examples of *E. californicus* in Pasadena in the attic of an old house which was being torn down. These bats were very much emaciated, and the stomachs were found to be empty. These specimens are now nos. 4326–4328, and 9438–9439 (Mus. Vert. Zool.).

On December 27, 1912, at the writer's suggestion, Mr. Charles L. Camp, of Sierra Madre, Los Angeles County, kindly investigated a rookery where he had found bats common in the summer time. This haunt was an old shedlike structure, some sixty feet long, and three stories high. The interior of the building was very dark and contained piles of old fruit-drying trays. In the summer time some bats had been found in between the trays, but more were discovered hanging to the shingles and rafters in the east gable of the building. The December visit revealed but a single living bat in the building, an *E. californicus.* This specimen was found hanging from the rafters. Near it hung a dead bat of the same species, evidently just killed and perhaps a victim of the unusually cold night which preceded the collector's visit. The mummified remains of a third individual of the species was found upon a heap of guano upon the floor of this gable, together with the dried remains of two specimens of *Antrozous pacificus*. A visit to the same place made on January 6, 1913, failed to reveal any bats.

The live *Eumops californicus* secured by Mr. Camp, December 27, 1912, at Sierra Madre was received at the Museum of Vertebrate Zoology, December 28. She hung herself up by the feet in a dark corner of the cage in which she was domiciled, and remained quiet until forcibly removed. She used feet and half-closed wings in an energetic endeavor to dislodge the writer's fingers from her back, and constantly kept her mouth opened to the widest extent in an effort to seize the fingers, all the while uttering shrill cries, loud enough to be heard at a distance of several hundred feet. These sounds might be likened to the utterances of a young robin in distress, and were cries, not mere squeaks.

When placed in a glass jar containing a bit of cotton saturated with ether the bat made strenuous efforts to escape, striking out with both feet and half-closed wings. While the bat was still partially under the influence of the anesthetic an endeavor was made to smooth her dampened and ruffled fur with a small brush. She curled and twisted about the offending object in a way which showed the greatest flexibility of body. When left to her own devices the bat clung to the rod above her with her right foot while with her left foot she thoroughly combed the dorsal surface of her left wing and her head and body on the left side, both dorsally and ventrally. Then shifting her hold to the other foot she repeated the combing process for the right half of her head and body with the alternate foot. Finally she became quiet and hung for a time motionless, her whole body being supported by one foot, the other hanging down on her back, the claws toward the center of her back and the folded ankle joint resting in a pocket formed by a fold of the wing membrane. Her eyes remained open but were completely in the shadows cast by the anterior margins of her ears and her loosely folded wings.

When the bat was placed gently upon the floor of her cage she scuttled backward with surprising rapidity, *backing* up the side of the cage until her nose just cleared the floor. She remained for some time in this position supporting herself by clinging with her claws to the unplaned surface of the board. When the observer returned to the cage an hour later the bat was found hanging head downward in a dark corner. In this position she remained for several days, and seemed absolutely indifferent to particles of fresh meat or insects held very near to her mouth.

When placed upon a smooth rug the bat scrambled forwards using her folded wings with great dexterity. In this instance the terminal joints of the wing were tucked away close to the bat's body, beneath the lateral membrane. When placed upon pebbly and twig-strewn ground the bat, before starting forwards, folded her slender wings closely and placed the delicate terminal portion upon the *dorsal* surface of the wing itself, in the angle between the humerus and radius, safe out of harm's way. After being kept alive in captivity for three weeks the bat was chloroformed, as it refused to eat. The weight of the living bat when first received was found to be 1½ ounces (42.5 grams).

In the latter part of May, 1913, Mr. Camp procured three more living *Eumops* from the same Sierra Madre haunt. These were kept alive at the Museum of Vertebrate Zoology from May 24 to June 5, 1913, and were then chloroformed, as they unfailingly ignored all food offered them. Each individual proved to be a female containing a single embryo. The breeding time of the species is thus indicated.

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PLATE 14

Fig. 1. Portion of Colorado Desert near Toro, Riverside County, showing entrance to cave occupied by colony of California leaf-nosed bats (*Macrotus californicus*). This cave and other similar ones in the vicinity also inhabited by bats were formed by wave action at the margin of the ancient Blake Sea. From these day-time retreats the bats issue forth at late dusk for nocturnal foraging over the adjacent desert.

Fig. 2. View in attic at home of R. B. Herron, Colton, San Bernardino County, showing clusters of Mexican free-tailed bats (*Nyctinomus mexicanus*) crowded together under the ridgepole in the peak of the roof. At the time of the observer's visit these bats were continually crowding and jostling each other in an apparent effort to squeeze still farther into the crevices. Other bunches of bats of the same species were seen in different parts of the garret, and at evening as the bats left this retreat through a slatted ventilator at the gable end, 1609 were counted. The photograph here reproduced was taken on October 27, 1916. Mr. Herron states that in midsummer the colony is much larger, including, he thinks, about 5000 individuals. Flashlight photograph by J. R. Pemberton.

Fig. 3. Station in the Transition life-zone near Fyffe, Eldorado County, with an incense cedar in foreground and yellow pines in background. Species of bats collected here July 19–31, 1916, were: *Lasionycteris noctivagans, Myotis californicus californicus, Myotis longicrus longicrus, Myotis lucifugus altipetens, Myotis thysanodes, Eptesicus fuscus*, and *Pipistrellus hesperus merriami*. This photograph shows an ideal collecting site, a tongue of cleared land projecting into a forested area.

Fig. 1

Fig. 2

Fig. 3

PLATE 15

Figs. 4, 5, 6. Photographs of a living lump-nosed bat (*Corynorhinus rafinesquii pallescens,* no. 21435, ♂), secured in a cave near Whitewater, Riverside County. × 1.00. Fig. 4 shows the bat in a dormant state, with wings held close to the body and ears folded back under them. The pinnae here are not bent sharply back, but curved by a regular and even crimping of the posterior edges of the auricles, the resulting appearance reminding the observer of the curving horns of a mountain sheep. Fig. 5 was taken when the animal had been disturbed and seemed to be endeavoring to overcome the lethargy of profound slumber. Fig. 6 shows the bat fully aroused and about to take flight. The successive positions of the ears illustrate the way in which they are unfurled.

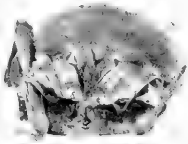

Fig. 4

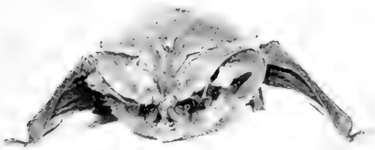

Fig. 5

Fig. 6

PLATE 16

Fig. 7. Hoary bat (*Nycteris cinerea*, no. 21439, ♀), secured at Fresno. Photographed under chloroform. Ventral view, × 0.43, showing tail curved over body ventrally. Note the furring of the dorsal surface of the interfemoral membrane and of the anterior portion of the ventral surface of the wing membranes.

Fig. 8. Hoary bat (*Nycteris cinerea*, no. 20778, ♂) front view, × 1.20. This figure shows the form of the ear and tragus, and the distribution of hair on the ventral surface of the ear; also the tumid-rimmed and widely separated nostrils.

Fig. 9. Spotted bat (*Euderma maculatum*, no. 1196), found dead in overflow from railway water tank, at Mecca, Riverside County. Photograph from dried skin. Dorsal view, × 0.41. Note the large ears, the parchment-like wing and tail membranes devoid of fur, and the striking color-pattern of the back. This coloration reminds the observer of the ''death's head'' pattern displayed upon the thorax in certain moths.

Fig. 7

Fig. 8

Fig. 9

PLATE 17

Fig. 10. Hoary bat (*Nycteris cinerea*, no. 20778, ♂), photographed under chloroform. Dorsal view, × 0.90. Note the large stout feet and thumbs; the thickly furred back and interfemoral membrane; the three small patches of light-colored fur, one on the antebrachial membrane at the proximal fifth of the forearm, one at the base of the fifth metacarpal, and one at the base of the thumb; and the long narrow wings, the third metacarpal far exceeding the fifth in length. The unusual length of the tail in this genus is not shown, as in this photograph the tip is turned under the body (see pl. 16, fig. 7).

Fig. 11. Pacific pallid bat (*Antrozous pacificus*, no. 9440, ♂), secured at Fresno. Photographed under chloroform. Dorsal view, × 0.50. The ears of this bat are separate and wide apart at base, and extend considerably beyond the tip of the snout. The feet are stout and more than half the length of the relatively short tibiae. The wings are short and broad, the third metacarpal being but slightly longer than the fifth.

Fig. 12. Lump-nosed bat (*Corynorhinus rafinesquii pallescens*), × 0.87. The bat is asleep, hanging head downward, and is supported mainly by the claws, which are thrust into a crevice in the angle where two boards join. The thumbs are turned back under the wings, and their claws thus aid in supporting the weight of the animal. One of the tragi shows clearly, as do the two glandular swellings on the snout.

Fig. 10

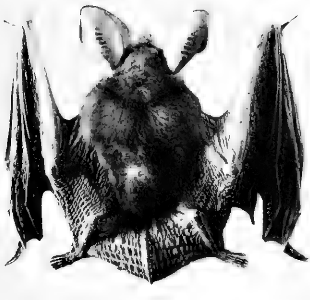

Fig. 11

Fig. 12

PLATE 18

Fig. 13. Large brown bat (*Eptesicus fuscus*, no. 22084, ♂), × 0.62. Dorsal view of fresh specimen secured in Yosemite Valley, Mariposa County. Note the heavily-built forearm, tibia and foot, and the stout thumb. The bluntly rounded ears of this bat are somewhat longer than broad, a fact not apparent in the photograph.

Fig. 14. Red bat (*Nycteris borealis teliotis*, no. 21516, ♀), × 0.55. Dorsal view of fresh specimen secured at Fresno. Note the small foot and ear, and the long interfermoral membrane, haired over the entire surface. The character of the dorsal pelage is well shown in this photograph: the frost-like light tippings of the hairs, and the short dense fur on the head as compared with the longer hair on the back.

Fig. 15. High Sierra bat (*Myotis lucifugus altipetens*, no. 23035, ♂), × 0.73. Dorsal view of fresh specimen taken at Vogelsang Lake, Mariposa County. Note the form of the ear (longer than broad and bluntly rounded at tip), the long slender thumb and the relatively long foot.

Fig. 16. Dorsal view of fresh specimen of Merriam bat (*Pipistrellus hesperus merriami*, no. 22081, ♂), secured at Pleasant Valley, Mariposa County; × 0.81. This bat and the one shown in fig. 17, *Myotis c. californicus*, are of somewhat similar size, but it will be noted that the ears of *californicus* are of nearly the same tone of coloration as the back, whereas the ears of *merriami* are of a blackish shade, contrasting with the grayish tone of the back. The ear in *merriami* is seen to be shorter than in *californicus*.

Fig. 17. Dorsal view of fresh specimen of little California bat (*Myotis californicus californicus*, no. 22078, ♂), secured at Pleasant Valley, Mariposa County. × 0.81.

Fig. 18. Living adult female red bat (*Nycteris borealis teliotis*, no. 24179) with her three young; × 0.44. This bat was found at Stockton, San Joaquin County, July 12, 1915, clinging to the trunk of a tree one and one-half feet above the ground, with the young all attached to her. Her weight was found to be 12.4 grams and the combined weights of the three young, 19.4 grams.

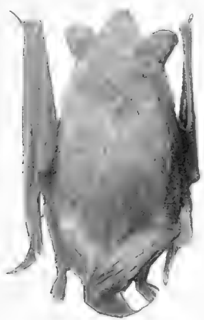

Fig. 13

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Fig. 16

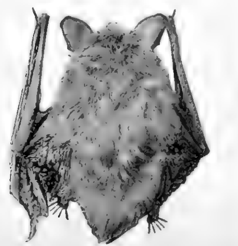

Fig. 17

Fig. 18

PLATE 19

Fig. 19. Mastiff bat (*Eumops californicus,* no. 19022 [or 1], ♀); × 0.41. Dorsal view of individual taken at Sierra Madre, Los Angeles County. Photographed under chloroform. Note the large ears, joined at their anterior bases; the long narrow wings, the fifth metacarpal being scarcely more than half the length of the third; the greatly exserted tail; the different quality of the pelage on the dorsal surface of the head from that on the back; the stout foot; and the short tibia.

Fig. 20. Mastiff bat (*Eumops californicus,* no. 19283 [or 2], ♀); × 0.58. Ventral view of individual taken at Sierra Madre, Los Angeles County. Photographed under chloroform. Note the downward-directed nostrils, huge mouth, wrinkled ears, long, slender wings, and stout thumbs.

Fig. 19

Fig. 20

PLATE 20

Fig. 21. Mastiff bat (*Eumops californicus*, no. 19021 [or 2], ♀); × 1.52. View of head with mouth opened to show dentition. Photograph of fresh specimen secured at Sierra Madre, Los Angeles County. Note the large ear directed outward and forward, the small truncate tragus, and the semi-oval antitragus which is separated from the rest of the auricle by a deep notch. The form and position of the nostrils is here well shown. It will be seen that the two upper incisors are long, slender, and in contact at their bases, though diverging at the tips.

Fig. 22. Dorsal view of skull of *Eumops californicus*, no. 4327, ♀. × 2.

Fig. 23. Side view of skull of *Eumops californicus*, no. 4327, ♀. × 2.

Fig. 21

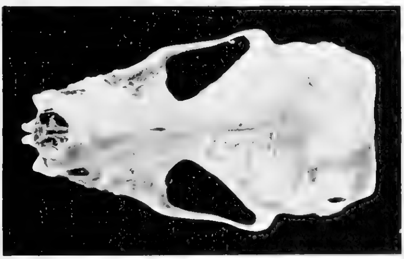

Fig. 22

Fig. 23

PLATE 21

Dorsal views of the skulls of twelve species of California bats. All × 2.

Fig. 24. *Myotis californicus californicus*, no. 18490, ♀.

Fig. 25. *Myotis californicus pallidus*, no. 17787, ♂.

Fig. 26. *Myotis orinomus*, no. 6941, ♀.

Fig. 27. *Pipistrellus hesperus hesperus*, no. 10409, ♂.

Fig. 28. *Myotis longicrus longicrus*, no. 20811, ♀.

Fig. 29. *Myotis yumanensis sociabilis*, no. 6651, ♀.

Fig. 30. *Myotis occultus*, no. 10706, ♂.

Fig. 31. *Myotis lucifugus altipetens*, no. 23036, ♀.

Fig. 32. *Myotis velifer*, no. 7762, ♂.

Fig. 33. *Lasionycteris noctivagans*, no. 24208, ♀.

Fig. 34. *Myotis evotis*, no. 6953, ♀.

Fig. 35. *Myotis thysanodes*, no. 29833 (U. S. Nat. Mus.), ♀.

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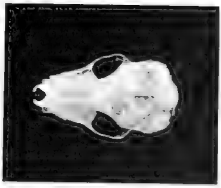

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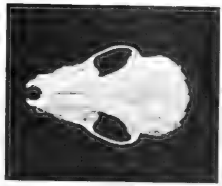

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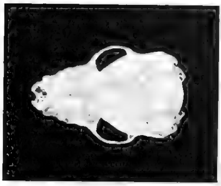

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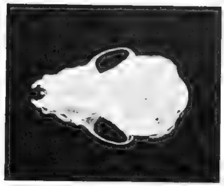

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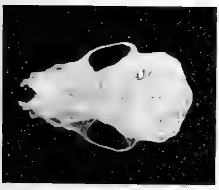

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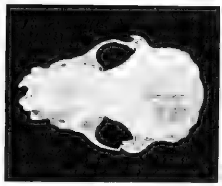

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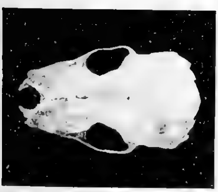

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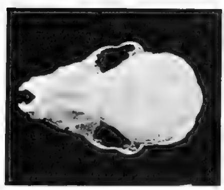

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PLATE 22

Side views of the same skulls as shown on plate 21. All × 2.

Fig. 36. *Myotis californicus californicus,* no. 18490, ♀.

Fig. 37. *Myotis californicus pallidus,* no. 17787, ♂.

Fig. 38. *Myotis orinomus,* no. 6941, ♀.

Fig. 39. *Pipistrellus hesperus hesperus,* no. 10409, ♂.

Fig. 40. *Myotis longicrus longicrus,* no. 20811, ♀.

Fig. 41. *Myotis yumanensis sociabilis,* no. 6651, ♀.

Fig. 42. *Myotis occultus,* no. 10706, ♂.

Fig. 43. *Myotis lucifugus altipetens,* no. 23036, ♀.

Fig. 44. *Myotis velifer,* no. 7762, ♂.

Fig. 45. *Lasionycteris noctivagans,* no. 24208, ♀.

Fig. 46. *Myotis evotis,* no. 6953, ♀.

Fig. 47. *Myotis thysanodes,* no. 29833 (U. S. Nat. Mus.), ♀.

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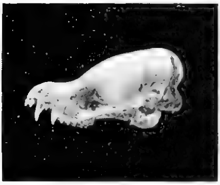

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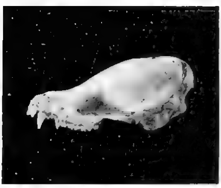

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PLATE 23

Dorsal views of the skulls of eight species of California bats. All × 2.

Fig. 48. *Nyctinomus mexicanus,* no. 6948, ♂.

Fig. 49. *Nycteris cinerea,* no. 6944, ♂.

Fig. 50. *Corynorhinus rafinesquii intermedius,* no. 6957, ♂.

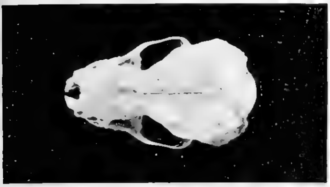
Fig. 51. *Nycteris borealis teliotis,* no. 24327, ♀.

Fig. 52. *Eptesicus fuscus,* no. 5176, ♂.

Fig. 53. *Antrozous pacificus,* no. 5248, ♂.

Fig. 54. *Macrotus californicus,* no. 1238, ♀.

Fig. 55. *Antrozous pallidus,* no. 7346, ♂.



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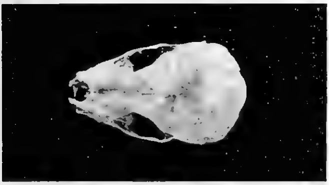

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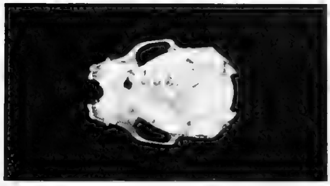

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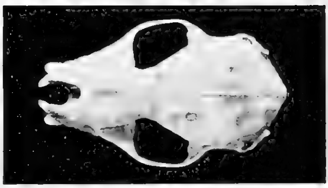

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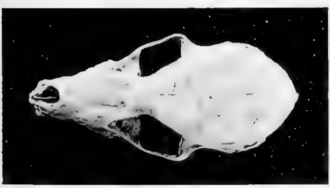

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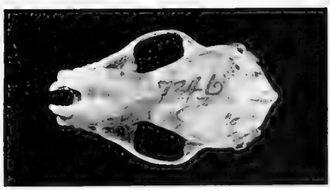

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PLATE 24

Side views of the same skulls as shown on plate 23. All × 2.

Fig. 56. *Nyctinomus mexicanus,* no. 6948, ♂.

Fig. 57. *Nycteris cinerea,* no. 6944, ♂.

Fig. 58. *Corynorhinus rafinesquii intermedius,* no. 6957, ♂.

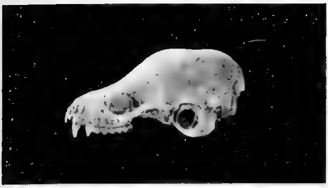
Fig. 59. *Nycteris borealis teliotis,* no. 24327, ♀.

Fig. 60. *Eptesicus fuscus,* no. 5176, ♂.

Fig. 61. *Antrozous pacificus,* no. 5248, ♂.

Fig. 62. *Macrotus californicus,* no. 1238, ♀.

Fig. 63. *Antrozous pallidus,* no. 7346, ♂.



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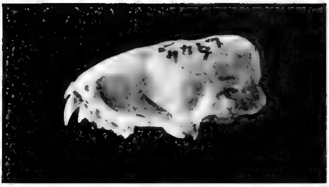

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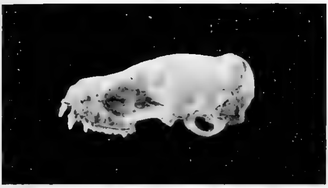

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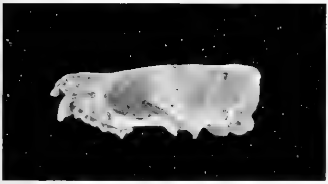

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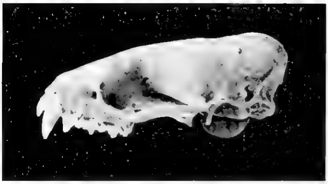

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THE PACIFIC COAST JAYS OF THE GENUS *APHELOCOMA*

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H. S. SWARTH

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THE PACIFIC COAST JAYS OF THE GENUS *APHELOCOMA*

BY

H. S. SWARTH

(Contribution from the Museum of Vertebrate Zoology of the University of California)

The present study is based principally upon the series of *Aphelocoma* in the Museum of Vertebrate Zoology, including, in addition to the specimens contained in the Museum collection, those in the Grinnell, Morcom and Swarth collections. Besides this material specimens were borrowed from other institutions and from individuals, as follows: From the Biological Survey, Washington, twelve skins from the San Pedro Martir Mountains, Lower California; from the Museum of Comparative Zoology, thirteen from the Cape San Lucas region, and two from northern Lower California; from the Museum of History, Science and Art, Los Angeles, four specimens from southern California; from the collection of the Oregon Fish and Game Commission, five specimens from Oregon; from the collection of J. and J. W. Mailliard, seventeen specimens, mostly from Marin County, California; from the collection of J. E. Thayer, twenty-five specimens from Lower California. The skins borrowed from outside sources are all in one way or another illustrative of points not covered by the collection of the Museum of Vertebrate Zoology, and the privilege of utilizing them added much to the value of the comparisons made. The writer wishes here to express his appreciation of, and thanks for, these generous loans. Altogether 437 specimens of *Aphelocoma* were examined.

Under each form, in the section giving "distinguishing characters," I have entered an exact statement of the color of a selected specimen, an average example of the race in fresh fall plumage. Color terms used are from Ridgway's *Color Standards and Color Nomenclature* (1912).

The genus *Aphelocoma* is, with the exception of the singularly isolated Florida species, restricted to the southwestern portion of North America. The several species included therein are for the most part rather sharply defined and not prone to split up into local races, though it is probably true that certain forms now recognized as "species" are as yet so imperfectly understood as to leave their true status and distribution a matter of some doubt.

In California there are three well defined species of the genus, *Aphelocoma californica* (divided in this state into three subspecies), *A. woodhousei,* and *A. insularis.* The first mentioned, in its three forms, occurs over the greater part of the state. It is primarily a bird of the Upper Sonoran zone, especially favoring those regions where there is live oak timber or scrub oak brush, and extending locally up into low Transition. It is apparently absent from the extreme northern coast region, as also from the mountains above Transition, and from the Lower Sonoran deserts of the southeast.

Aphelocoma woodhousei occupies disconnected areas of Upper Sonoran on certain of the mountain ranges of the Inyo region, and on the east slope of the Sierra Nevada. *A. insularis* is found only on Santa Cruz Island. These three species are distinguished by certain trenchant characters. The Santa Cruz Island jay appears to be cut off from contact with its nearest mainland relative by the intervening channel, though the distance to be traversed is not so great as, on the face of it, to be considered an impassable barrier to a bird of this nature. *A. californica* and *A. woodhousei* meet at the east base of the Sierra Nevada, where at certain seasons both species may be found at the same places; for the most part the specific characters of each remain stable along this border line.

The California forms of *Aphelocoma* all belong to a section of the genus that it seems to me is deserving of recognition, nomenclaturally, as distinct from another aggregation now included in the same genus. *Californica, woodhousei, insularis,* and *hypoleuca,* together with *cyanea* and certain other Texan and Mexican species, all possess in common certain conspicuous features of structure, coloration, etc., and all are as sharply distinguished from the *Aphelocoma sieberi* group. Coues (1903, pp. 497, 499) proposed that the latter be separated as a subgenus "*Sieberocitta,*" as distinguished from true *Aphelocoma.* This suggested subgenus was not accepted by the A. O. U. Committee (1908, p. 394), because of being "based on color characters alone." As a matter of fact the distinguishing features (as was pointed out by

Coues) are matters of structure (at least such as are commonly used in distinguishing bird genera), of color, of eggs, and of habits. In *Sieberocitta*, as compared with true *Aphelocoma*, besides the obvious and constant color differences, the tail is shorter instead of longer than the wing, and the eggs are plain blue instead of double pigmented. The call-notes of the two are widely different. Of habit differences it may be noted that while *Aphelocoma* is relatively solitary in its mode of life, *Sieberocitta* is as markedly gregarious as the Piñon Jay (*Cyanocephalus cyanocephalus*), going habitually in closely assembled flocks of twenty or thirty individuals, and even nesting in rather loose rookeries. Another feature of *Sieberocitta* is its habit of constructing extra nests, as the Marsh Wren does.

The point here made is that in the genus *Aphelocoma* there are these two aggregations of species and subspecies, each group distinguished by certain features, common to all the forms therein, of coloration and pattern, structure, eggs, call-notes and habits. The two groups occur to a large extent over the same territory, where, however, they occupy slightly different ecologic niches, *Sieberocitta* being primarily a bird of open oak woods, true *Aphelocoma*, of denser underbrush. It seems to me that it is desirable that these two groups be accorded subgeneric recognition.

If it were feasible to consider all the forms of true *Aphelocoma* as subspecies of one species, and all of *Sieberocitta* as of another, this might equally well serve to segregate them as they should be, but the facts hardly permit of such treatment.

There is still another feature of the situation, namely, the relationship of the Mexican and Central American species, *Aphelocoma unicolor;* but this I am not qualified to discuss.

In a recent paper, primarily on the status of *Aphelocoma texana*, but incidentally discussing other allied forms, Oberholser (1917, p. 94) advocates that all of the "*Aphelocoma californica* group" be regarded as subspecies of one species, *A. californica*. This includes all the forms that I would restrict to the subgenus *Aphelocoma*, except *A. cyanea* and *A. insularis*. Mr. Oberholser and myself are, perhaps, merely stating the same thing in different ways. My main objection to his conception of the forms as subspecific variants is that much of the intergradation to which he calls attention occurs only through *individual* variation, in races that are geographically far apart. Individual variation in *sumichrasti*, in southern Mexico, is said to cover the difference between that form and *A. californica*

californica (Oberholser, *loc. cit.*), and the same is true as between *A. californica immanis* of the Sacramento Valley, and *A. hypoleuca* of Cape San Lucas, but in each case the region between these forms is occupied by a race or races different from either.

It seems to me that there is danger of giving too much emphasis to the resemblances noted, and of losing sight of the significant fact that there is no blending of characters where the different forms meet. For example, although in the three subspecies of *Aphelocoma californica,* as I would restrict them, *californica, oocleptica,* and *immanis,* there is such intergradation at the margins of the several habitats, nothing of the sort can be detected along the boundary between *immanis* and *woodhousei.* It is true that there is a specimen at hand that may be regarded as intermediate between these two latter forms (see beyond), but this is a single sporadic individual, and the circumstance appears to be exactly comparable with conditions observed to exist in *Psaltriparus minimus californicus* and *P. plumbeus,* of the same region. In both cases in this marginal region the populations in general of the several species are as typical in appearance as are those at opposite extremes in the birds' ranges. It is just an occasional individual which shows any admixture of characters of the adjoining races.

The manner of variation to be traced through the several subspecies of *Aphelocoma californica* differs in some respects from what may be observed among other variable species of birds. *Aphelocoma* is not an especially "plastic" group, the several species being for the most part rather sharply defined, and remaining uniform in appearance over a wide expanse of territory. In the three recognizable subspecies of *A. californica* occurring within the state of California, the manner of variation is unlike what is observed in the races of such species as *Pipilo maculatus* and *Thryomanes bewicki,* for, as shown in the accompanying table, in *Aphelocoma* the several characters concerned vary, to all appearances, independently, and not always in the same direction.

Characters which have been used to differentiate species and subspecies in the genus *Aphelocoma* pertain to size and color. Size characters consist of general size, length of wing, length of tail, length of bill and bulk of bill. Color characters used are: shade of the blue areas, of dorsum, of under parts, of under tail coverts.

It should be noted that characters of color are quite as apparent in the juvenal plumage as in the adult, and, when the quill feathers

Variable features in *Aphelocoma californica* and *A. hypoleuca* listed to show differences occurring in the several faunal areas occupied.

	Cape San Lucas (*A. hypoleuca*)	Northern Lower California (*A. c. californica*)	San Diegan region (*A. c. californica*)	Santa Cruz region (*A. c. californica*)	San Francisco Bay region (*A. c. oocleptica*)	Coast region north of the Golden Gate (*A. c. oocleptica*)	Sacramento Valley (*A. c. immanis*)	Sierra Nevada (*A. c. immanis*)	Warner Mountains (*A. c. immanis*)	Oregon (*A. c. immanis*)
Relative size	Larger	Smaller	Smaller	Smaller	Larger	Larger	Larger	Larger	Larger	Larger
Length of wing	124.2	120.4	118.8	119.8	126.	125.4	124.3	126	127.	126.4
Length of tail	138.2	134.4	132.5	131.6	140.	136.7	137.5	140.7	138.2	137.7
Depth of bill at nostril	9.2	8.2	8.3	9.1	9.5	9.1	9.1	9.3	9.1	9.7
Shade of blue	Pale Neropalin blue	Dark (deep cadet blue)	Dark (deep cadet blue)	Dark (deep cadet blue)	Dark (deep cadet blue)	Dark (deep cadet blue)	Chapman's blue	Chapman's blue	Chapman's blue	Chapman's blue
Color of back	Light drab, suffused with bluish	Sepia	Sepia	Sepia	Sepia	Sepia	Drab	Drab	Drab	Drab
Color of under surface of body	White, light suffusion of gray	Slaty	Slaty	Slaty	Slaty	Whitish with slaty suffusion	White, light suffusion of gray	White, light suffusion of gray	White, light suffusion of gray	White, light suffusion of gray
Color of under tail coverts	White	White, frequently tinged with blue	White, frequently tinged with blue	White, frequently tinged with blue	White, frequently tinged with blue	White	White	White	White	White
Juvenal plumage	....	....	Dark	Dark	Dark	Dark	Pale	Pale	Pale	Pale

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have attained their full size, length of wing and tail are also equally characteristic in the young. In several instances in the present study, where localities have been represented by adults in worn, midsummer plumage, the appearance of young birds taken at the same time pointed unmistakably toward the relationships of the series in question.

On the accompanying table the variable features in *Aphelocoma californica* are listed so as to show the differences occurring in the birds of the several faunal areas inhabited. Where there is little or no difference in a character in two or more of such areas, the dividing line is lightly indicated. Where there is an appreciable discrepancy this line is heavy. Thus in the diagram, differentiating characters are segregated by locality regardless of subspecific names.

It will be observed of the Cape San Lucas bird (*hypoleuca*) that in every particular it is sharply set off from its nearest neighbor, *californica*, so much so that, if, as seems highly probable, there is a stretch of country between the two uninhabited by the genus, *californica* and *hypoleuca* might well be considered distinct species rather than subspecies of the same form. It is true that although *Aphelocoma hypoleuca* and *A. californica* as occurring in northern Lower California (*A. c. californica*) are so abruptly and absolutely different, *hypoleuca* and Sacramento valley *californica* (*A. c. immanis*) are distinguished with difficulty; but this seems to be a case of parallel modification of widely separated forms, races that really have but little in common.

It will also be noted upon the diagram, relating to the species as occurring in California and Oregon, that although no line of separation can be drawn between any two adjacent regions for *all* the characters considered, certain divisions can be made by combination of various of the differentiating features. Disregarding the Cape San Lucas bird, it will be seen that beginning at northern Lower California there is increase of size northward; not evenly, however, for although a line drawn between the Santa Cruz and San Francisco Bay regions will separate smaller sized birds to the southward from larger ones to the northward of this point, there is no appreciable size difference between birds of the Santa Cruz area and northern Lower California on the one hand, nor between those of the San Francisco Bay area and Oregon, on the other.

There is no appreciable difference in length of culmen from Cape San Lucas to Oregon (see table), but depth of bill increases northward, more northern birds consequently possessing proportionately heavier bills. As seen in the diagram it is in this one particular that birds of the Santa Cruz area resemble the northern form more nearly than the southern.

In coloration it will be noted that there is practical uniformity of appearance, on the one hand, in birds of the coast region from northern Lower California to Humboldt Bay, on the other, in birds from the Sacramento-San Joaquin Valley, Sierra Nevada, Warner Mountains, and Oregon.

Aphelocoma californica californica (Vigors)

Type locality.—Monterey, California.

Range.—A relatively narrow strip along the coast of California and northern Lower California; from the San Pedro Martir Mountains, Lower California, north on the coastal slope of California, west of the southern Sierras and the coast ranges, through the San Diegan and Santa Cruz districts to the south side of San Francisco Bay.

Specimens examined from the following localities: Lower California: San Pedro Martir Mountains, 6; Hanson Laguna Mountains, 5; Ensenada, 1; 30 miles east of San Quintin, 1; Santana, 2.

California: San Diego County—Witch Creek, 7; Cuyamaca Mountains, 2; Julian, 4; Foster, 2; Dulzura, 1; Campo, 1; Warner Pass, 1; San Diego, 1; Pala, 1. Orange County—Trabuco Cañon, 2; Laguna Beach, 1. Riverside County—San Jacinto Mountains, 16; Vallevista, 1; San Gorgonio Pass, 2; Riverside, 1. San Bernardino County—Reche Cañon, 3; San Bernardino Mountains, 5. Los Angeles County—Pasadena, 39; San Fernando Valley, 2; Santa Monica Mountains, 4; Verdugo, 1; Glendora, 2; Chileo, 1; San Francisquito Cañon, 1; Los Angeles, 3. Ventura County—Ventura, 2; Mount Pinos, 3. Santa Barbara County—Santa Barbara, 1; Guadalupe Lake, 1. San Luis Obispo County—Paso Robles, 1. San Benito County—Paicines, 2. Monterey County—Pacific Grove, 3; Partington Pt., 2; Lucia 2. Santa Clara County—Palo Alto, 7; San Jose, 1; Berryessa, 1; College Park, 2. Total 147.

Distinguishing characters.—*Aphelocoma californica californica,* compared with *A. c. immanis,* is of small size and dark coloration. The blue areas are of a deeper shade, the back distinctly darker brown, and the light colored under parts have a dusky suffusion. Lower tail coverts usually tinged with blue, sometimes conspicuously so. Coloration is about the same in *californica* as in *oocleptica,* from which subspecies *californica* is distinguished by smaller size throughout. Compared with *A. hypoleuca, A. c. californica* is of much darker coloration, and, on the average, slightly smaller size. No. 7016 (Mus. Vert. Zool.), male, Palo Alto, California, November 21, 1906. Blue areas, deep cadet blue; dorsum, sepia.

Remarks.—In the material assembled for the present study the subspecies *Aphelocoma c. californica* is represented by a fairly satisfactory series from Lower California (unsatisfactory only in that it includes no specimens in fresh fall plumage), by skins from the San

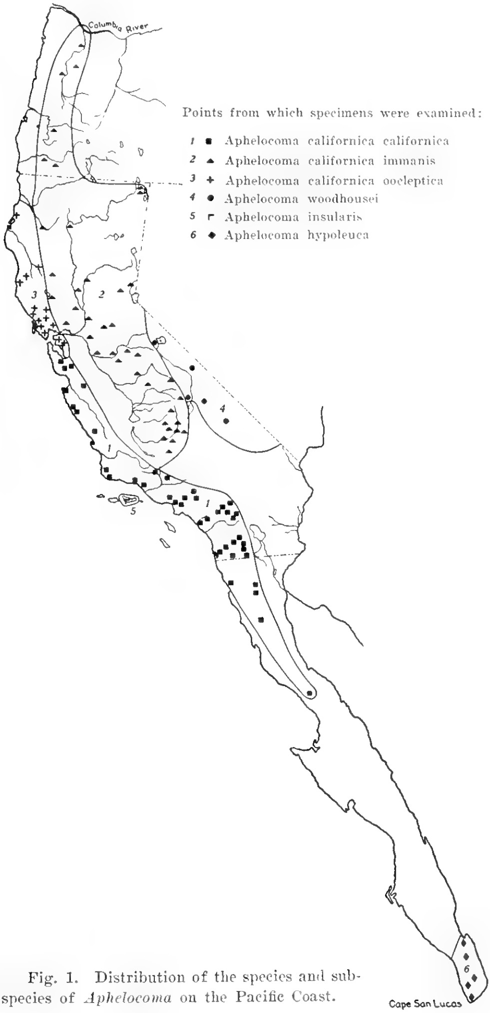

Fig. 1. Distribution of the species and subspecies of *Aphelocoma* on the Pacific Coast.

Diegan region representing a large number of record stations and illustrating practically all phases of variation, and by smaller series from a number of points along the coast north to San Francisco Bay.

The most important point to be considered in a systematic study of birds from these several sections is the relationship borne by *A. c. obscura*, described from the San Pedro Martir Mountains, Lower California, to *A. c. californica*, with type locality at Monterey. The present treatment of the races of the California jay differs from that in most recent literature covering the subject (e.g., A. O. U. *Check-list*, 1910, p. 225; Ridgway, 1904, pp. 327–331) in that it does not recognize the subspecies *obscura*. This race was described by Anthony (1889, p. 75) from specimens taken in the San Pedro Martir Mountains, Lower California. In a subsequent paper (1893, p. 239) the same writer asserts that birds from the San Pedro Martir Mountains and from San Diego County, California, are indistinguishable, and for some years past the name *obscura* has been generally used to cover the bird of the San Diegan region of California, as well as that of northern Lower California. Comparison of series from these points, however, with specimens from various coastal localities as far north as San Francisco Bay (including the vicinity of Monterey, the type locality of *californica*), shows that all belong to the same race, that there are no characters serving to distinguish specimens from these several places. Hence the name *obscura* must be considered a synonym of *californica*.

Aphelocoma californica obscura was described as a smaller and darker colored bird than *A. c. californica*. Perpetuation of this error may have occurred through comparison of southern California specimens with others from the Sacramento Valley or the Sierra Nevada, in the belief that the latter were representative of typical *californica*. This assumption is wrong, however, and although jays from certain sections of California may readily be distinguished as, respectively, larger and paler, or smaller and darker, true *californica* and *obscura* both fall into the latter category. This point has been discussed and the same conclusion reached by Grinnell and Swarth (1913, p. 261), with reference to the status of the species as occurring in the San Jacinto Mountains, southern California.

The range of *Aphelocoma c. californica* abuts that of *A. c. oocleptica* on the north, and that of *A. c. immanis* on the northeast. Whether or not there is continuous distribution of jays of this species over the length of Lower California, with consequent contact of the ranges of *californica* and *hypoleuca,* I do not know. There are no specimens of either at hand illustrative of marked variation toward the neighboring race.

In southern California, as far north as Fort Tejon, the eastern boundary of the range of *californica* is sharply defined by the western margins of the Colorado and Mohave deserts. At this point the subspecies *californica* extends in typical form to the eastern bases of the surrounding coast ranges, and stops there abruptly. The Lower Sonoran deserts form a broad and impassable barrier to birds of this genus.

Farther north, from the northern boundary of Ventura County northward, while there is no such evident obstacle to distribution, there is an extensive stretch of country, the arid, timberless west side of the San Joaquin Valley, where conditions are so unfavorable to the species that it is almost, if not entirely, absent. I have considered the range of *A. c. californica* as lying just west of this section. There are no specimens at hand from any point in this region. There are available three skins from the vicinity of Mount Piños, Ventura County, and two from Paicines, San Benito County, these points lying approximately along the dividing line between the ranges of *californica* and *immanis.* Of the specimens from the Mount Piños region, two November birds from the head of Piru Creek show a decided approach to Sierra Nevada *immanis.* In fact, regarded by themselves they might well be considered as belonging to that subspecies, but considering the manner in which the section where they were taken is separated from the range of *immanis,* and the continuous distribution of *californica* from this point westward, they had, perhaps, better be regarded as individual extremes of *californica,* taken at the edge of its range and illustrating intergradation with *immanis.* The two Paicines specimens are also evidently intergrades toward *immanis,* though not leaning so markedly toward the latter race. There are specimens at hand from various points along the coastal slope of Santa Barbara, San Luis Obispo, Monterey, and Santa Clara counties, as already enumerated, and these are so obviously like the bird of southern California and northern Lower California as to leave no doubt as to their subspecific identity.

Aphelocoma californica oocleptica, new subspecies

Type.—Male adult, no. 7123, Mus. Vert. Zool.; Nicasio, Marin County, California; February 23, 1909; collected by Walter P. Taylor; original number 647.

Range.—The coast region of northern California, west from Mount Diablo and the coast ranges. North to Humboldt Bay, south to the Golden Gate and the east side of San Francisco Bay.

Specimens examined from the following localities: Alameda County—Oakland, 1; Piedmont, 1; Berkeley, 9. Contra Costa County—Walnut Creek, 5; Mount Diablo, 3; Danville, 5. Marin County—Mailliard, 1; Inverness, 3; Nicasio, 4; San Geronimo, 3. Sonoma County—Sonoma, 1; Stony Point, 2; Freestone, 1; Guerneville, 10; Santa Rosa, 1. Mendocino County—Mendocino City, 1; Mount Sanhedrin, 2; Bald Hill, 1; Sherwoods, 2. Humboldt County—Arcata, 1. Total 57.

Distinguishing characters.—Of large size and dark coloration. In color closely similar to *A. c. californica,* but size measurably greater throughout. In measurements *oocleptica* is equal to the maximum of *immanis,* from which subspecies it is distinguished by its dark coloration. Differs from *hypoleuca* both in greater size and much darker color.

No. 6001 (Mailliard coll.), male, Nicasio, Marin County, October 29, 1894. Blue areas, deep cadet blue; dorsum, sepia.

Remarks.—It was an unexpected development of the present study that there should be disclosed the presence of an additional race of *Aphelocoma* within the state. The specimens at hand, however, are ample for the establishing of this subspecies, the characters exhibited being clearly defined, and the territory occupied by the form capable of being outlined with a fair degree of accuracy. While in the combination of characters possessed *oocleptica* might be considered as an intergrade between *californica* and *immanis,* still it is not truly intermediate between the two. It has assumed the distinctive characters of large size (equal to the pale colored *immanis*), and dark coloration (as in the small sized *californica*), each to the fullest degree. It is the combination of these two features that distinguishes the race.

There is more evident appearance of intergradation between *oocleptica* and *immanis,* than between the former and *californica.* Of the last mentioned form, examples from points immediately south of San Francisco Bay (closely approaching the range of *oocleptica*) are indistinguishable from specimens from southern California, there being no appreciable increase in size. On the other hand, at points where the ranges of *oocleptica* and *immanis* come together (as in parts of Marin and Sonoma counties), individuals exhibiting various degrees of intergradation between the two are of frequent occurrence. In southern Marin County somewhat similar conditions prevail in *Aphelocoma* as have already been noted of other variable groups in the same region as *Psaltriparus* (Swarth, 1914, pp. 513–515) and *Thryomanes* (Swarth, 1916, p. 66), namely, the frequent occurrence of individuals evincing a marked tendency toward the appearance of the neighboring race of the nearby Sacramento Valley. There is a series of *Aphelocoma* at hand from that portion of Sonoma County wherein, as described by J. Mailliard (1908, p. 133), there occurs a form of *Cyanocitta* closely approaching the interior form *frontalis* rather than the coastal race *carbonacea.* In the *Aphelocoma* of this strip of country it is again of interest to note that in birds taken at points extending practically to the coast, coloration is appreciably paler than in typical *oocleptica,* closely approaching that seen in Sacramento Valley *immanis.*

In the region immediately west of San Francisco Bay, birds from the vicinity of Berkeley and Oakland exhibit the extreme of large size and dark coloration. Just a few miles away, however, on the farther slope of the hills to the westward of these points, the jays exhibit a pronounced leaning toward *immanis.* A series of five birds taken at a point in this region (near Danville, Contra Costa County), and in fresh fall plumage, are noticeably pale colored, strikingly similar to specimens from the Sierra Nevada. I include this region in the range of *oocleptica,* however, partly because of the slightly darker tone of coloration of adult birds from this section (as compared with Sierran *immanis*), and largely because in the juvenal plumage (as exhibited in specimens from Mount Diablo and Walnut Creek) there is no variation from the corresponding stage as it occurs in Marin County. In typical *immanis* the juvenal plumage is as conspicuously different from *oocleptica* as is the adult.

Aphelocoma californica immanis Grinnell

Type locality.—Scio, Linn County, Oregon.

Range.—Extreme southern Washington, in Oregon those valleys lying between the Cascades and the Coast Ranges, and south in California through the Sacramento and San Joaquin valleys and the Sierra Nevada. East to the Warner Mountains and the eastern base of the Sierra Nevada.

Specimens examined from the following localities:

Oregon: Linn County—Scio, 4. Benton County—Corvallis, 1. Multnomah County—Portland, 2. Josephine County—Grant's Pass, 1. Jackson County—Gold Hill, 2. Douglas County—Roseburg, 1. "Willamette Valley," 1.

California: Modoc County—Warner Mountains, 38. Trinity County—Helena, 1. Shasta County—Baird, 1. Nevada County—Independence Lake, 1; Little Truckee River, 1. Placer County—Cisco, 1. Inyo County—Kearsarge Pass, 2; Carroll Creek, 1. Kern County—Onyx, 1; Walker Pass, 1; Fay Creek, 5; Bodfish, 2; Piute Mountains, 4; Caliente, 1. Tulare County—Taylor Meadow, 4; Trout Creek, 4; Cannell Meadow, 2. Fresno County—Dunlap, 4; Minkler, 14. Madera County—Raymond, 1. Mariposa County—El Portal, 7; Coulterville, 2. Merced County—Snelling, 2. Stanislaus County—La Grange, 1; Modesto, 3.

San Joaquin County—Tracy Lake, 3. Sacramento County—Sacramento, 3. Amador County—Carbondale, 2; Drytown, 1. Solano County—Vacaville, 5. Glenn County—Winslow, 5. Yolo County—Knight's Landing, 1. Butte County—Oroville, 1. Sutter County—Sutter, 1. Lake County—Lower Lake, 1. Total 139.

Distinguishing characters.—Of large size and pale coloration. Under tail coverts usually pure white; sometimes slightly tinged with blue; brown of back pale, as compared with *californica,* and suffused with grayish. Under parts white, with but a slight suffusion of slaty. Distinguished from *A. c. californica* both by large size and pale coloration; from *oocleptica* by pale coloration, size being about the same. *Aphelocoma hypoleuca* is smaller than the maximum of *immanis,* though closely matched in this respect by the series from the Sacramento Valley. In coloration *hypoleuca* is constantly paler than the lightest colored *immanis.*

No. 269 (coll. of S. G. Jewett), male, Portland, Oregon, November 5, 1905; blue areas, Chapman's blue; dorsum, hair brown, with bluish tips to the feathers.

Remarks.—*Aphelocoma californica immanis* was described by Grinnell (1901, p. 188), from the Willamette Valley, Oregon, characterized as a bird of larger size and with longer tail than *A. c. californica.* The subspecies was denied recognition by the A. O. U. Committee (1901, p. 312), as indistinguishable from *A. c. californica,* a logical point of view, of course, considering the recognition already accorded by that committee to *A. c. obscura* as a smaller and darker bird than true *californica.* There is no question as to the existence of the two distinguishable races, the large, pale colored form to which the term *californica* is incorrectly applied by Ridgway (1904, p. 327) and the A. O. U. Committee (1910, p. 225), and the small, dark colored subspecies termed *obscura* by the same authorities. The realization, however, that *obscura* is a synonym of *californica,* both pertaining to the subspecies occurring in the southern coast district of California, necessitates the affixing of a name to the form inhabiting the interior of the state. In a recent paper Oberholser (1917, p. 94) affirms the existence of the subspecies *immanis,* defining its range as including parts of Oregon and extreme northern California. There are at hand large series of jays from the interior valleys of California, the Sierra Nevada, and the Warner Mountains, and as, on comparison, these are indistinguishable from specimens from the Willamette Valley, Oregon, the name which has been used for the latter bird, *immanis,* must be applied to this whole aggregation.

On the east slope of the Sierra Nevada the ranges of *immanis* and *woodhousei* meet, and here is where intergradation of characters between the two should be found if it occurs at all. *Woodhousei* is found in this section in the fall, but whether or not it breeds here is not known. The probabilities are that it does not, and that the birds that have been taken in the region in the autumn were wanderers from points farther east. However this may be, there is one specimen at hand from this section, taken at 5,500 feet elevation on Carroll Creek, Inyo County, that in color and markings exhibits a blending of the characters of the two forms. This bird, an adult male (no. 20068, September 9, 1911), is of a decidedly paler blue than are comparable specimens from the west side of the Sierras, while the dorsum is bluish gray, rather than brownish, as in the latter. Whiteness of under parts of body and lower tail coverts, the streakings upon the breast, and measurements and proportions, are all exactly as in *immanis*. This bird therefore must be classed with the latter form, but the dorsal appearance of the specimen is strikingly similar to fall examples of *woodhousei*, and quite different from any other specimen of *immanis* at hand. The nature of this departure from the usual coloration of *immanis*, occurring in a specimen from this particular region has undoubtedly some significance as regards the relationships of the two forms. For the present, however, I prefer to regard them as specifically distinct, for the same reasons as those advanced in the case of the two species of *Psaltriparus* that occur here; the observed conditions are closely similar. (See Swarth, 1914, p. 521.)

There are two breeding birds at hand from this section, taken near the east base of Kearsarge Pass in June (nos. 22504, 22505). The feathers are too abraded to be of service in color comparisons, but to all appearances these birds are typical of *immanis*.

Aphelocoma woodhousei (Baird)

Type locality.—Fort Thorn, New Mexico.

Range in California.—Upper Sonoran zone in the desert mountains of the eastern part of the state, in the Inyo and Mohave regions. At the eastern base of the Sierra Nevada, probably as a transient only.

Specimens examined from the following localities:

California: Inyo County— Carroll Creek, 1; Hanaupah Cañon, Panamint Mountains, 3; Johnson Cañon, Panamint Mountains, 6; Jackass Spring, Panamint Mountains, 9; Silver Cañon, White Mountains, 6; Robert's Ranch, White Mountains, 1; Keeler, 1. Mono County—Williams Butte, 2; Benton, 3.

Arizona: Huachuca Mountains, 5. Santa Catalina Mountains, 2. Rincon Mountains, 1. Dragoon Mountains, 3.

Nevada: Quinn River Crossing, Humboldt County, 1.

Total 44.

Distinguishing characters.—Compared with any of the subspecies of *Aphelocoma californica, A. woodhousei* differs in coloration and in proportions of bill. The blue areas are dull and pale, the back is strongly suffused with bluish gray, and the under parts and throat with gray; the under tail coverts are blue. The general effect of these modifications is to produce a much more uniformly and inconspicuously marked bird than *A. californica.* The bill of *woodhousei* averages longer than in *californica*, but is more slender. From *A. insularis, woodhousei* differs constantly in its subdued and uniform coloration, and smaller size.

No. 25934 (Mus. Vert. Zool.), male, Williams Butte, Mono County, California, September 21, 1915. Blue areas, Columbia blue; dorsum and lower parts, suffused with bluish throughout.

Remarks.—The range of the Woodhouse jay in California is restricted to scattered and disconnected areas of Upper Sonoran in the Inyo region, the arid desert section of the eastern part of the state. In the late summer and fall it is a visitant to the eastern slope of the Sierra Nevada, where it comes into direct contact with *A. c. immanis*, but it apparently does not breed in this section. Carroll Creek, just south of Mount Whitney, is the southernmost record station, though there is no evident reason why the species should not extend much farther south and west.

Comparison of three California specimens at hand in fresh fall plumage, with individuals taken at the same season in southern Arizona, shows no differences between the two lots.

Aphelocoma insularis Henshaw

Type locality.—Santa Cruz Island, California.

Range.—Santa Cruz Island, California.

Specimens examined.— From Santa Cruz Island, 14.

Distinguishing characters.—Distinguished from any subspecies of *A. californica* by greater size, darker coloration, and definitely blue under tail coverts. From *A. woodhousei*, which it resembles in its blue under tail coverts, *insularis* is distinguished by greater size, darker coloration, and (like *A. californica*) in more strongly contrasted markings.

No. 5458 (coll. of J. Grinnell), male, Santa Cruz Island, September 3, 1903. Blue areas, deep dull violaceous blue; dorsum, clove brown.

Remarks.—The Santa Cruz jay is in many respects one of the most remarkable species that has been produced upon the Santa Barbara Islands. Each of the animal forms evolved upon these islands has developed in ways deserving the most careful study, for neither in the trend taken by the characters serving to distinguish them from their mainland relatives, nor in the distribution of species upon the islands, is it possible to detect uniformity in the results attained. In the particular species in question certain anomalies stand out even more conspicuously than in any of the other island birds.

The Santa Cruz jay is one of the most sharply differentiated of any of the island species, and it is hard to appreciate the possibility of the development of the form under the given conditions. Santa Cruz is the only one of the Santa Barbara Islands upon which jays of any sort are found, though other species of birds far more sedentary in their manner of life, are widely distributed over the group, and conditions upon some, at least, of the other islands would permit the existence of the jay. Santa Cruz is not so widely distant from the mainland but what it would seem possible for jays to travel back and forth. While the California jay of the adjacent mainland strictly speaking is not a migratory species, still in the fall small flocks may occasionally be seen wandering far from their breeding grounds, in territory where they certainly never nest, and it would seem not unlikely, under the circumstances, for individuals from the mainland to reach the islands occasionally, and vice versa.

Then, as regards the extreme differentiation achieved by the Santa Cruz jay, it is of interest to make comparisons with other variable forms occurring upon the same island.

The spotted towhee (*Pipilo maculatus*) as it occurs upon Santa Cruz is indistinguishable from the mainland subspecies, *megalonyx,* though upon others of the islands there is the subspecies *clementae,* with strongly developed characters. The Bewick wren (*Thryomanes bewicki*) upon Santa Cruz Island is recognized separately, as the subspecies *nesophilus*, but it is with difficulty distinguished from the race *charienturus* upon the adjoining mainland, while again upon other of the islands there are races with much more strongly marked features. The bush-tit (*Psaltriparus minimus*), Hutton vireo (*Vireo huttoni*), and perhaps one or two other species, occur upon Santa Cruz alone of the Santa Barbara Islands—as does the jay—yet none of these have developed into recognized insular races.

On the whole it is evident that Santa Cruz Island has not served as a differentiating center to the same extent as other islands of the group; yet at the same time it has produced in the Santa Cruz jay the most strongly characterized of any of the island races.

The most striking feature of the Santa Cruz jay, as compared with the mainland species is its enormous size, so in this case a marked restriction of range, with consequent probability of inbreeding of closely related individuals has not been productive of the dwarfed stature which such conditions are supposed to engender.

Aphelocoma hypoleuca Ridgway

Type locality.—La Paz, Lower California.

Range.—"Cape district of Lower California . . ., north to about latitude 28°" (Ridgway, Birds of North and Middle America, 3, 1904, p. 331).

Specimens examined from the following localities:

Lower California—La Paz, 8; Miraflores, 10; El Sanz, 4; Sierra de Laguna, 5; Santa Anita, 1; Cape San Lucas, 7; Triunfo, 1.

Total 36.

Distinguishing characters.—The pale coloration of *hypoleuca* serves to distinguish it from any of the related species or subspecies on the Pacific Coast. The blue areas are distinctly lighter than in even the palest examples of *immanis*, and the under parts are of a more nearly immaculate white.

No. 11917 (coll. of John E. Thayer), male, Sierra de Laguna, Lower California, August 25, 1908. Blue areas, Neropalin blue; dorsum, light drab, suffused with bluish.

Remarks.—It is a difficult matter to come to a decision as to the proper nomenclatural treatment that should be accorded this form, though it is my impression that it is best regarded as a distinct species, rather than as a subspecies of *Aphelocoma californica*. The one great objection to this course is the close resemblance of *hypoleuca* to the form of *Aphelocoma* occurring in northern California. Whether this possibly fortuitous general resemblance of the two is sufficient to outweigh the several arguments in favor of their distinctness, is a question, but the fact remains that it is almost impossible to designate characters whereby *hypoleuca* and series of *immanis* from certain points can be distinguished without fail.

So much may be said in opposition to the concept of specific difference. The arguments in favor of such a view are essentially as follows:

1. The features in which *hypoleuca* differs from the form geographically nearest to it (*A. c. californica*) are not in accord with the trend of variation observed in *A. californica* over its range as a whole.

2. Between *californica* of northern Lower California, and *hypoleuca* of the southern end of the peninsula, the change in appearance is abrupt, comparable to the difference between *immanis* and *woodhousei*, where the latter meet in California. Two specimens of *californica* from Santana, Lower California (Thayer coll. nos. 6353, 6552) are indistinguishable from comparable examples from southern California. Santana is about midway the length of Lower California, and at a point where, if intergradation between *californica* and *hypoleuca* occurs, specimens secured should illustrate this condition. That

these two skins are typical of *californica* is an argument in favor of the specific distinction of the two forms.

As regards the first of these two points, it will be noted that although series of *californica* from northern California (*A. c. immanis*), are closely similar to *hypoleuca,* the form geographically closest adjacent to the range of *hypoleuca* (*A. c. californica,* of the San Pedro Martir Mountains) is the farthest removed from it in all its characters.

As can be seen on the accompanying table (opp. p. 408) the course of variation in *Aphelocoma californica* is, in general terms, as follows. At the northern extreme of its range there is a large, pale colored form, restricted to the interior valleys and mountains. This, in the central coast region merges into a large, dark colored race, which, in turn, to the southward passes into the smaller, but dark colored, race that extends into northern Lower California. Then, abruptly, after what appears to be an absolute break in continuity of range, there is the large, pale colored form, *hypoleuca.*

The fact that *hypoleuca* has been heretofore described as smaller than *californica* is probably due to comparisons being made with series of the form *immanis.* Compared with *A. c. californica* from the Santa Cruz or San Diegan districts it is, as shown in the accompanying table, of larger size than these birds. Measurements of *hypoleuca* are about equal to those of *immanis* from the Sacramento Vallev or Sierra Nevada, and smaller than those of series from extreme northern California and Oregon.

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Measurements in Millimeters (Average, Minimum and Maximum) of the Pacific Coast Forms of *APHELOCOMA*

	Wing	Tail	Culmen	Depth of bill at nostril	Tarsus	Middle toe without claw
Aphelocoma hypoleuca						
10 males, Cape region, Lower California	124.2 (120.5–127.0)	138.2 (133.0–146.0)	26.3 (24.0–28.0)	9.2 (8.8– 9.8)	38.4 (37.0–40.5)	23.0 (22.0–23.5)
Aphelocoma californica californica						
7 males, San Pedro Martir and Hanson Laguna Mts., Lower California	120.4 (117.0–125.0)	134.4 (130.0–141.0)	25.5 (24.0–27.0)	8.2 (8.0– 8.5)	39.7 (38.5–40.5)	21.8 (20.0–23.0)
6 males, San Diego and Orange counties, California	118.8 (114.0–122.0)	132.5 (126.0–137.0)	25.7 (25.0–27.0)	8.3 (8.2– 8.5)	38.6 (38.0–39.5)	21.8 (21.0–22.5)
10 males, Los Angeles County, California	119.0 (116.0–121.0)	132.8 (128.0–139.0)	25.9 (24.0–27.5)	8.8 (8.0– 9.2)	39.7 (38.0–41.0)	22.5 (21.0–23.5)
8 males, Monterey and Santa Clara Counties, California	119.8 (118.0–122.0)	131.6 (125.0–137.0)	25.8 (25.0–27.0)	9.1 (8.0–10.0)	40.3 (38.0–43.0)	23.5 (22.0–25.0)
Aphelocoma californica oocleptica						
7 males, Marin County, California	125.4 (122.0–128.0)	136.7 (129.0–142.0)	25.8 (23.0–27.0)	9.1 (8.5– 9.5)	41.5 (39.0–43.0)	23.8 (22.5–24.5)
Aphelocoma californica immanis						
8 males, Sacramento Valley, California	124.3 (122.0–129.0)	137.5 (130.0–146.0)	25.4 (24.0–27.0)	9.1 (8.5– 9.2)	40.2 (39.0–41.5)	24.4 (23.0–26.0)
10 males, Sierra Nevada, California	126.0 (122.0–128.0)	140.7 (135.0–148.0)	25.4 (24.0–26.5)	9.3 (8.8–10.0)	40.8 (38.0–42.0)	23.2 (21.0–24.0)
6 males, Warner Mts., California	127.0 (125.0–134.0)	138.2 (131.0–148.0)	25.1 (24.0–27.0)	9.1 (8.5– 9.5)	40.7 (39.0–42.0)	24.0 (23.0–25.0)
7 males, Oregon	126.4 (121.0–131.0)	137.7 (130.0–146.0)	25.6 (24.5–27.0)	9.7 (9.2–10.0)	41.6 (40.0–44.0)	24.2 (23.0–25.0)
Aphelocoma insularis						
6 males, Santa Cruz Island, California	135.5 (134.0–138.0)	154.0 (151.0–158.0)	32.8 (31.5–34.0)	10.1 (10.0–10.2)	46.3 (45.5–47.0)	24.9 (24.0–26.0)
Aphelocoma woodhousei						
7 males, California and Arizona	125.8 (121.0–129.0)	136.0 (123.0–143.0)	26.6 (26.0–27.8)	8.1 (8.0– 8.5)	39.5 (38.0–42.0)	22.1 (21.0–23.0)

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14. SIX NEW MAMMALS FROM THE MOHAVE DESERT AND INYO REGIONS OF CALIFORNIA

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15. NOTES ON SOME BATS FROM ALASKA AND BRITISH COLUMBIA

BY
HILDA WOOD GRINNELL

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SIX NEW MAMMALS FROM THE MOHAVE DESERT AND INYO REGIONS OF CALIFORNIA

BY
JOSEPH GRINNELL
(Contribution from the Museum of Vertebrate Zoology of the University of California)

Field work carried on under the auspices of the California Museum of Vertebrate Zoology during 1917 in southeastern California brought to light many new facts in regard to the general distribution and speciation of the endemic vertebrate animals. Some of these facts, as concerning certain of the mammals, are set forth in the present paper.

Scapanus latimanus monoensis, new subspecies

Mono Mole

Type.—Female adult, skull (with teeth worn) and skin (in summer pelage); no. 25834, Mus. Vert. Zool.; Taylor Ranch, two miles south of Benton Station, Mono County, California; August 29, 1917; collected by H. G. White; original no. 1376.

Diagnosis.—A small-sized member of the *Scapanus latimanus* group of moles (see Jackson, 1915, pp. 64–75); similar to its near neighbor on the south, *S. l. grinnelli*, but color mouse gray (of Ridgway, 1912, pl. 51) instead of fuscous-black, and size slightly less. Resembles *S. l. dilatus* in color but size very much less.

Measurements.—Average of eight adults (the first three features as taken by the collector in the field): total length, 150 millimeters; tail vertebrae, 33; hind foot, 20.6; greatest length of skull, 32.9; mastoid breadth, 16.2; interorbital breadth, 7.5. Extremes are shown in the accompanying table (1).

Distribution.—Known only from two localities, both in Mono County, California: vicinity of Williams Butte, near Mono Lake; and vicinity of Benton. The total available material representing this form is listed in the accompanying table.

TABLE 1

Measurements, in millimeters, of Eight Specimens of *Scapanus latimanus monoensis*, from Mono County, California

Museum number	Sex	Exact locality	Date	Collector	Total length	Tail vertebrae	Hind foot	Greatest length of skull	Mastoid breadth	Interorbital breadth
23966	♂	Farrington's Ranch, 6800 ft., ¾ mile south Williams Butte	June 28, 1916	J. Dixon	152	34	22	33.1	16.0	7.5
25828	♀	Taylor Ranch, 5300 ft., two miles south Benton Station	Aug. 28, 1917	A. C. Shelton	136	29	20	31.8	15.9	7.3
25829	♂	Taylor Ranch, 5300 ft., two miles south Benton Station	Aug. 28, 1917	A. C. Shelton	150	34	21	33.3	16.5	7.8
25830	♀	Taylor Ranch, 5300 ft., two miles south Benton Station	Aug. 28, 1917	A. C. Shelton	161	36	22	33.7	16.5	7.7
25831	♀	Taylor Ranch, 5300 ft., two miles south Benton Station	Aug. 28, 1917	H. G. White	150	34	20	33.4	16.4	7.6
25832	♀	Taylor Ranch, 5300 ft., two miles south Benton Station	Aug. 28, 1917	H. G. White	141	33	20	32.8	16.2	7.5
25833	♀	Taylor Ranch, 5300 ft., two miles south Benton Station	Aug. 29, 1917	H. G. White	160	32	20	32.8	16.1	7.3
25834[1]	♀	Taylor Ranch, 5300 ft., two miles south Benton Station	Aug. 29, 1917	H. G. White	151	32	20	32.3	16.2	7.5

[1] Type.

Thomomys melanotis, new species

White Mountains Pocket Gopher

Type.—Male adult, skull and skin (in nearly full new pelage); no. 26499, Mus. Vert. Zool.; 10,500 feet altitude on Big Prospector Meadow, White Mountains, Mono County, California; July 27, 1917; collected by A. C. Shelton; original no. 3402.

Diagnosis.—A *Thomomys* with characters of the "*perpallidus* group" in part and of the "*alpinus* group" in part (see Bailey, 1915, pp. 33, 63, 68). General coloration very pale, almost identical with that in *T. perpallidus perpallidus,* differing from that form only in more dusky nose and mouth and in more extensive, slaty black, ear-patch. Ear extremely small, rounded, and densely clothed with fine black hairs. General size medium, about as in *T. alpinus alpinus.* Skull relatively narrow, and with slender rostrum and unaccentuated ridges, thus resembling *alpinus;* but dentition lighter, interorbital constriction narrower, and auditory bullae much larger.

Comparisons.—In coloration, much paler and grayer than any of its geographical neighbors (*Thomomys perpallidus perpes, T. scapterus, T. operarius,* and *T. alpinus alpinus*). Differs from *perpes* otherwise in smaller and more hairy ears, extensively black ear-patch, lighter skull, narrower interorbital constriction, narrower rostrum, slenderer zygomata, much smaller teeth, and larger auditory bullae. Differs from *scapterus* in larger size, extensively black ear-patch, more widely and more squarely spreading zygomatic arches, broader brain-case, much longer nasals, and larger auditory bullae. Differs from *operarius* in conspicuously black-haired ears, extensive black ear-patch, lighter and slenderer skull, much narrower rostrum, more projecting incisors, much lighter dentition, constricted nasals, narrower interorbital constriction, and more inflated auditory bullae. Differs from *alpinus* in more extensive black ear-patch, less projecting incisors, much smaller molar teeth, narrower interorbital constriction, and much larger auditory bullae.

Measurements.—See Table 2; compare with those of various gophers as given in Bailey (1915).

Distribution.—The nine specimens secured (see table) were all taken in the Canadian and Hudsonian life-zones, 10,000 to 10,500 feet altitude, on, and within three miles of, Big Prospector Meadow, White Mountains, Mono County, California.

Remarks.—The writer confesses his inability, with the material now available, to determine satisfactorily the relationships of this new gopher. It was thought at first to belong unquestionably to the *alpinus* group and to constitute a sequestered and far differentiated form within that series. A few gophers from the vicinity of Benton, Mono County, and elsewhere in the northern end of Owens Valley, however, show characters which make it seem possible that *melanotis* has been derived from the lowland *perpallidus* stock through altitudinal invasion. Further acquisition of specimens from the Inyo region will be needed to clear up the question.

TABLE 2

Measurements, in millimeters, of Nine Specimens of *Thomomys melanotis*, all from Vicinity of Big Prospector Meadow, White Mountains, Mono County, California

Museum number	Sex, age	Date (1917)	Collector	Total length	Tail vertebrae	Hind foot	Ear, from crown	Basilar length of skull	Greatest length of nasals	Zygomatic breadth	Mastoid breadth	Least inter-orbital breadth	Alveolar length upper molar series
26497	♀ jv.	July 25	A. C. Shelton	188	56	26	3	25.8	9.4	18.6	16.5	6.3	6.9
26498	♂ ad.	July 27	A. C. Shelton	218	70	30	4	32.7	13.3	23.5	20.2	6.5	7.8
26499[1]	♂ ad.	July 27	A. C. Shelton	225	72	30	4	34.6	13.6	25.7	20.9	6.9	7.7
26500	♀ ad.	July 31	A. C. Shelton	223	64	28	4	32.1	13.3	24.1	19.4	6.4	7.8
26501	♀ ad.	Aug. 1	A. C. Shelton	215	70	26	4	32.1	12.9	22.6	19.3	6.3	7.9
26502	♀ ad.	July 26	J. Grinnell	195	55	26	3	31.0	12.5	22.3	19.0	6.5	7.3
26503	♂ ad.	July 27	J. Grinnell	245	79	32	3	36.1	13.8	25.6	21.0	5.7	8.2
26504	♀ ad.	July 28	J. Grinnell	192	56	28	3	31.4	12.0	22.3	19.0	6.5	7.3
26505	♀ ad.	July 30	J. Grinnell	205	66	28.5	4	32.7	12.3	23.4	19.5	6.0	7.5

[1] Type.

Thomomys perpallidus mohavensis, new subspecies

Mohave River Pocket Gopher

Type.—Male adult, skull and skin; no. 4639, Mus. Vert. Zool.; Mohave River bottom, 2700 feet altitude, near Victorville, San Bernardino County, California; December 26, 1904; collected by J. Grinnell and J. Dixon; original no. 906.

Diagnosis.—A *Thomomys* of the "*perpallidus* group" (see Bailey, 1915, pp. 33, 68). Resembles *T. perpallidus perpallidus* cranially, but color much darker above, bright cinnamon-buff (of Ridgway, 1912, pl. 29), and tail shorter; differs from *T. p. perpes* (topotypes) in lighter, more cinnamon tone of coloration dorsally, in slightly larger size, in greater and squarer spread of zygomatic arches, in more projecting incisors, and in much larger auditory bullae.

Measurements.—See Table 3.

Distribution.—Abundant along the bottomlands of the Mohave River, in San Bernardino County, at least from Victorville down (north) to Barstow; also, transversely, along the southern rim of the Mohave Desert, from Cushenbury Springs, San Bernardino County, west at least to Fairmont, Los Angeles County.

Remarks.—As already stated, by Bailey (1915, p. 69), pocket gophers are not continuously distributed over the desert areas of the Southwest. Wide areas are unrepresented at all, these animals thus occurring in more or less remotely isolated colonies, usually where permanent moisture produces a continuous growth of edible plants. The larger valleys, like those of the Mohave and Owens rivers, well separated from one another by desert reaches, have evidently served as effective differentiation centers, and we find several distinguishable races of the pocket gopher accordingly. It seems equally true that some of the higher and more isolated of the mountain ridges of the

TABLE 3

Measurements, in Millimeters, of Eight Adult Specimens of *Thomomys perpallidus mohavensis*, all Collected by J. Grinnell and J. Dixon in the Vicinity of Victorville, San Bernardino County, California

Museum number	Sex	Date	Total length	Tail vertebrae	Hind foot	Basilar length of skull	Greatest length of nasals	Zygomatic breadth	Mastoid breadth	Least interorbital breadth	Alveolar length upper molar series
4639[1]	♂	Dec. 26, 1904	235	75	31	36.4	15.5	26.1	20.7	6.4	8.0
4646	♂	Dec. 29, 1904	227	76	30	33.0	12.2	23.0	19.5	6.6	7.8
4660	♂	Dec. 31, 1904	223	75	28	34.9	12.9	24.4	20.1	6.2	7.6
4661	♂	Dec. 28, 1904	228	66	30	37.0	15.7	27.8	21.9	6.7	8.1
4644	♀	Dec. 31, 1904	195	62	28	30.6	10.0	22.3	18.1	6.5	7.6
4647	♀	Jan. 1, 1905	212	60	29	32.3	13.0	23.5	19.8	6.9	7.7
4648	♀	Dec. 27, 1904	230	69	30	32.2	12.4	23.4	20.1	6.5	8.0
4650	♀	Dec. 27, 1904	210	70	29	31.9	13.0	23.7	20.0	6.7	7.3

[1] Type.

same general region have operated in similar fashion, because of the soil-moisture maintained thereon. *Thomomys perpallidus mohavensis* and *T. p. perpes* are valley forms; *T. scapterus* and *T. melanotis* are montane forms.

Perodipus mohavensis, new species

Mohave Kangaroo Rat

Type.—Male adult, skin and skull; no. 26835, Mus. Vert. Zool.; 3275 feet altitude, half mile east of railway station of Warren (about five miles north of Mohave), Kern County, California; March 27, 1917; collected by J. Grinnell; original no. 3942.

Diagnosis.—A medium sized rather small eared, buff-colored *Perodipus*, perhaps nearest like *P. panamintinus*. Differs from topotypes of that form in somewhat smaller size, decidedly smaller ears, much more ochraceous-buffy tone of coloration, in less amount of black about the face, slightly narrower skull, and in less inflated auditory bullae.

Measurements.—See table 4 (compare with measurements given by Merriam, 1894, 1904, and 1907, for the different species of *Perodipus* described by him).

Distribution.—Specimens at hand indicate the presence of this form along the western border of the Mohave Desert at least from Walker Pass, northeastern Kern County, south to Fairmont, northwestern Los Angeles County.

TABLE 4

Measurements, in millimeters, of Ten Adult Specimens of *Perodipus mohavensis*, all Collected by J. Grinnell and J. Dixon near Mohave, Kern County, California, March 26 and 27, 1917

Museum number	Sex	Total length	Tail vertebrae	Hind foot	Ear, from crown	Total length of skull	Breadth of skull across bullae	Greatest length of nasals	Width of maxillary arch at middle
26835[1]	♂	305	178	44	12	40.7	25.0	15.8	5.2
26837	♂	295	175	44	12	39.4	24.1	15.1	5.0
26839	♂	290	175	44	13	39.2	24.5	14.6	4.7
26841	♂	300	180	41	13	40.0	24.4	15.5	5.3
26843	♂	305	180	45	13	41.0	25.3	15.8	5.3
26830	♀	288	172	40	10.5	38.1	23.3	14.3	4.7
26832	♀	285	167	43	12	39.4	24.8	15.0	4.8
26834	♀	295	173	42	11	39.6	24.0	14.8	4.9
26840	♀	285	170	43	14	38.3	23.2	14.6	4.8
26842	♀	300	175	44	13	39.3	24.0	14.9	5.2

[1] Type.

Callospermophilus chrysodeirus perpallidus, new subspecies

Inyo Golden-mantled Ground Squirrel

Type.—Male adult, skull and skin (in partially new winter pelage, otherwise worn breeding pelage); no. 27488, Mus. Vert. Zool.; 10,300 feet altitude, near Big Prospector Meadow, White Mountains, Mono County, California; July 26, 1917; collected by J. Grinnell; original no. 4334.

Diagnosis.—Resembles *Callospermophilus chrysodeirus chrysodeirus* of the Sierra Nevada, but general coloration paler; middle of back, rump and sides, more ashy in tone, head less richly tawny, and under surface of body whiter. As a result, the black dorsal stripes give an impression of greater sharpness. Resembles *C. trepidus* of the Pine Forest Mountains, northern Nevada, but tail shorter and coloration even paler.

Material.—Forty-five specimens, from the Inyo and White mountains, 7,000 to 11,600 feet altitude, Inyo and Mono counties, California. Southernmost station, Mazourka Cañon, at 7700 feet altitude, in the Inyo Mountains directly east of Independence.

Measurements of type.—Total length, 265 millimeters; tail vertebrae, 90; hind foot, 39; height of ear from crown, 13.

Remarks.—This is simply a pale desert-range race, probably cut off but incompletely from its near relative, *chrysodeirus*, of the Sierra Nevada.

Ochotona schisticeps sheltoni, new subspecies

White Mountains Cony

Type.—Male adult, skull and skin (showing chiefly newly acquired winter pelage); no. 27560, Mus. Vert. Zool.; 11,000 feet altitude, near Big Prospector Meadow, White Mountains, Mono County, California; July 29, 1917; collected by A. C. Shelton; original no. 3414.

Diagnosis.—Nearest like *Ochotona schisticeps schisticeps* in general coloration; tones of color fully as dark dorsally, but belly and tops of feet less pervaded with tawny; ears blackish, margined more conspicuously with white. Cranium as in ***O.** s. schisticeps*, ***O.** s. muiri*, and ***O.** s. albatus* (between which three Sierran races there appear to be no cranial differences) but with notably larger auditory bullae, and with brain-case higher, more curved dorsally as seen in profile.

Measurements of type.—Head and body, 188 millimeters; tail vertebrae, 8; hind foot, 30; height of ear from crown (inner base), 24; total weight, 132.5 grams; occipito-nasal length of skull, 42.8 millimeters; height of brain-case at bullae, 15.6; greatest cranial width including bullae, 21.8; greatest diameter of bulla (diagonally anteroposteriorly), 13.7.

Material.—Thirty-nine specimens, all taken in the White Mountains, in Mono and Inyo counties, California, at altitudes ranging from 8,200 to 11,900 feet.

Remarks.—Because of the aridity of the White Mountains I had expected to find the cony on this range relatively light colored, possibly identical in this regard with the pale-colored race *albatus* of the Mount Whitney region. It turns out, however, that the White Mountains animal is darker even than *muiri* of the Yosemite region, closely resembling in color tone the race *schisticeps* of the northern Sierras from the Tahoe region northward.

As elsewhere, the conies in the White Mountains live in rock slides and broken-up rock outcrops. Two colors of rocks occur in this range, a blackish or dark red "shale," and a white or grayish white granite. There are extensive belts purely of one or the other kind of rock. Our party took pains to shoot conies from each color of ground, keeping notebook record of where each specimen was shot. I am unable to detect any difference in color between animals shot from white granite and those from dark "shale."

The new subspecific name, *sheltoni,* is selected in recognition of the efficient services as field collector rendered the Museum of Vertebrate Zoology by Mr. Alfred C. Shelton. It was chiefly through his tireless effort that the excellent series of White Mountains conies was obtained.

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Transmitted March 5, 1918.

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Vol. 17, No. 15, pp. 431-433 April 25, 1918

NOTES ON SOME BATS FROM ALASKA AND BRITISH COLUMBIA

BY
HILDA WOOD GRINNELL
(Contribution from the Museum of Vertebrate Zoology of the University of California)

The following notes seem worthy of publication as being contributory to the very meager knowledge so far available in regard to the bats of Alaska and British Columbia. Specimens from these regions are very slow to accumulate; as they do become more plentiful it is inevitable that previous views in regard to identity and relationships of the species represented be more or less modified.

Myotis longicrus longicrus (True)

Among the twelve specimens of bats listed from Admiralty and Baranof islands, Alaska, by Heller (1909, p. 264) under the name *Myotis lucifugus alascensis*, there is one which is clearly referable to the *longicrus* group. This specimen (♂, no. 186, Mus. Vert. Zool.) was collected by C. Littlejohn at Mole Harbor, Admiralty Island, June 9, 1907. It measures in millimeters: total length, 90.0; tail, 40.0; forearm (both defective); tibia, 18.0; foot, 9.0; greatest length of cranium, 14.3; breadth of brain-case, 7.5. In color this example is deep Vandyke brown both above and below, the hairs with tippings of cinnamon brown. The coloration of this specimen is almost identical with that of examples of *longicrus* taken in northwestern California. The characters of this individual throughout thus align it with *Myotis longicrus longicrus.*

In his account of a collection of birds and mammals from Vancouver Island, British Columbia, Swarth (1912, pp. 109, 110) mentions a bat (♀, no. 12588, Mus. Vert. Zool.) taken at Errington, August 31, 1910, which he refers to the form *Myotis lucifugus alascensis*, stating that "the specimen is so imperfect as not to admit of exact identification." While the tibiae of this bat are mutilated, it is otherwise in good condition and the skull is perfect, showing the up-turned rostrum and the facial angle typical of *Myotis longicrus longicrus*. The forearm of this bat measures 36 millimeters, the greatest length of cranium, 14.3, and breadth of brain-case, 7.5. In color this example is very close to the specimen from Admiralty Island, Alaska, described above, but the hair tippings both above and below are lighter, more ochraeous-buff.

In so far as the writer is aware *Myotis longicrus longicrus* has not hitherto been recorded from farther north than the type locality, Puget Sound, Washington.

Myotis lucifugus alascensis Miller

Among some bats belonging to the Biological Survey collection, United States National Museum, and loaned to the writer through the courtesy of Mr. E. W. Nelson, are four skins (three with skulls) from Skidegate, Queen Charlotte Islands, British Columbia. These specimens (nos. 100675–100678) are adult males collected by W. H. Osgood in July, 1900, and are presumably the four recorded (Osgood, 1901, pp. 36, 37) under the name *Myotis yumanensis saturatus*. The three skulls measure in millimeters: no. 100675, greatest length of cranium, 14.7; breadth of brain-case, 7.3; no. 100676, greatest length of cranium, 14.7; breadth of brain-case, 7.6; no. 100677, greatest length of cranium, 14.9; breadth of brain-case, 7.4. The specimens in all their characters show their identity with the bat now currently known as *Myotis lucifugus alascensis*.

Myotis californicus caurinus Miller

There are in the collection of the Museum of Vertebrate Zoology two mummified specimens of *Myotis californicus caurinus* collected by W. D. McLeod at Howkan, Long Island (near Dall Island), southeastern Alaska. These bats measure in millimeters: no. 19292 (skull removed): forearm, 31.7; tibia, 12.3; thumb, 3.6; greatest length of skull, 13.1; breadth of brain-case, 6.8. No. 19293: forearm, 32.2; tibia, 13.5; thumb, 3.9. In color these two examples are closely similar; the fur is everywhere plumbeous-black at the bases of the hairs and deep Prout's brown at the tips; under surface slightly lighter than dorsal surface.

This appears to constitute the first record of *Myotis californicus caurinus* from Alaska.

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REVISION OF THE RODENT GENUS *APLODONTIA*

BY
WALTER P. TAYLOR

UNIVERSITY OF CALIFORNIA PRESS
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CONTENTS

A. INTRODUCTION

1. Prefatory Remarks

Discovered by Lewis and Clark in the early years of the nineteenth century, the peculiar west American rodent genus *Aplodontia* has long attracted interest and attention. It is the sole living representative of that primitive group of rodents, the Aplodontoidea (see Matthew, *in* Osborn, 1910, pp. 534, 535), from which all other members of the order have been presumed to be derived, and constitutes a stock which is one of the most conservative known in the class Mammalia. The family to which it belongs (the Aplodontiidae) was the sole mammalian family cited by Wallace (1876, p. 127), as characteristic of his Californian subregion of Nearctica, and is remarkable for its present restricted distribution, being found only on the Pacific coast of North America, in an area which may be bounded roughly by southern British Columbia on the north, the Sierra-Cascade mountain system on the east, and the latitude of San Francisco Bay on the south (see map, text-fig. H).

The unusual characters of the genus *Aplodontia* (see pls. 26, 27), together with the scarcity of fossil remains representative of it, have made the determination of its systematic status a matter of exceptional difficulty. Minding (1829, p. 86) referred the genus *Anisonix* [= *Anisonyx* = *Aplodontia* (part)] to the family Prensiculantia, in which it is associated with twenty-seven other genera, ranging from *Castor*, *Hydromys* and *Mus* to *Bathyergus*, *Tamias* and *Chiromys*. Two years later Bonaparte (1831, p. 20) associated the genus *Aplodontia* with twenty other genera in his "section" Sciurina of the family Muridae. Swainson (1835, p. 388) put *Aplodontia* in his "Division I" of the Order Glires which contained twenty-two additional genera. By Schinz (1845, pp. 120, 139) the genus was referred to the family Cunicularia, in which were included also arvicolines, octodonts, pocket gophers, and mole-rats. Gervais (1854, p. 364) grouped *Aplodontia* with the pocket gophers. Baird (1857, p. 350) included *Aplodontia* in the subfamily Castorinae; Lilljeborg (1866, opp. p. 9) referred it to the porcupines; Peters (1865, pp. 177, 179), Alston (1876, p. 66, and pl. 4, opp. p. 61), Coues (1877*b*, pp. 543, 601) and others placed it with the squirrels. Gill (1872, p. 22) referred the Haploodontidae to a superfamily Haploodontoidea, listing it as equivalent in rank to the Castoroidea and Sciuroidea; Zittell (1894, p. 523) included the Haplodontidae with certain aberrant families of rodents in his Protrogomorpha; and Thomas (1896, pp. 1014, 1015) accorded to the Aplodontiidae and Anomaluridae separate group rank, leaving it for further research to show their true relationships. The latest classification is that of Matthew and Osborn in 1910, according to which the Aplodontiidae are associated with three extinct families of rodents in the superfamily Aplodontoidea.

Thirteen forms of *Aplodontia* Recent have been described, nine being here recognized. The first formal description was that of

Rafinesque, who characterized "*Anisonyx? rufa*" in 1817 (p. 45) on the basis of Lewis and Clark's account of the sewellel as observed in the neighborhood of the Columbia River. In 1829 Richardson (1829*a*, pp. 333–337) described *Aplodontia leporina* on the basis of specimens collected by David Douglas from within the range of what is now regarded as *Aplodontia rufa rufa*. For thirty-six years no further new names appeared. In 1865 (pp. 177–179) Peters named *Haplodon leporinus* var. *Californicus* from a specimen received at the Berlin Museum, said to have come "aus den Gebirgen Californien." It is the opinion of the writer that this name is tenable for the aplodontia of the Sierra Nevada Mountains of California, which was described by Dr. C. Hart Merriam in 1886 (p. 316) under the name *Aplodontia major*. Four forms of *Aplodontia* were described by Dr. Merriam in 1899*a* (pp. 19–21), as follows: *Aplodontia pacifica*, type locality, Newport, Oregon; *Aplodontia phaea*, type locality, Point Reyes, California; *Aplodontia olympica*, type locality, Quiniault Lake, Washington; and *Aplodontia major rainieri*, type locality, Paradise Creek, Mount Rainier, Washington.

In 1914 two additional forms were described from California: *Aplodontia chryseola* (here referred to *rufa*), from Jackson Lake, Siskiyou County, by Kellogg (p. 295), and *Aplodontia nigra*, from Point Arena, by the present writer (p. 297). Two years later three more forms were characterized by the writer: *Aplodontia californica columbiana*, from Roab's Ranch, near Hope, British Columbia (Taylor, 1916*c*, p. 499); *Aplodontia rufa grisea* (1916*c*, p. 497, here referred to *rufa*), from the vicinity of Seattle, Washington; and *Aplodontia humboldtiana* (1916*a*, pp. 21–24), from the Humboldt Bay region, California.

2. Material and Acknowledgments

The work here reported upon was begun while the writer was a staff-member at the Museum of Vertebrate Zoology, University of California, and finished after his appointment to the staff of the Bureau of Biological Survey, Washington, D. C. Exclusive of fossil material the present study is based on the examination of 369 specimens, for the most part skins with skulls contained in the collections of the two institutions named.

Through the courtesy of Professor John C. Merriam the writer has had access to the University of California Collections in Vertebrate

Palaeontology, in which are contained some of the most interesting and important specimens known bearing upon the history of the Aplodontiidae and the apparently related fossil family Mylagaulidae.

Acknowledgments are due the following persons: For the loan of additional material for study, to Messrs. F. J. V. Skiff and Wilfred H. Osgood, of the Field Museum of Natural History, Dr. John F. Bovard and Mr. Alfred C. Shelton, of the University of Oregon Museum, and Messrs. Samuel Henshaw and Outram Bangs, of the Museum of Comparative Zoology; for the courtesy of access to the collection under his charge, to Mr. Gerrit S. Miller, Jr., of the United States National Museum; for helpful suggestions regarding the historical problems involved, to Dr. John C. Merriam, of the University of California; for various suggestions in connection with the work, to Messrs. E. W. Nelson, T. S. Palmer, Vernon Bailey, Edward A. Preble, and Hartley H. T. Jackson, of the Biological Survey, and to Messrs. Gerrit S. Miller, Jr., and J. W. Gidley, of the United States National Museum; for a list of vernacular names of *Aplodontia* used by California Indians, to Dr. C. Hart Merriam, of the Harriman Foundation, Smithsonian Institution; and for critical oversight, to Dr. Joseph Grinnell, of the Museum of Vertebrate Zoology, University of California, at whose instance the work was undertaken.

3. Methods of Measurement

All measurements are in millimeters.

Cranial measurements, except where otherwise specified, are taken as follows:

Basilar length: inferior lip of foramen magnum to posterior margin alveolus of incisor.

Length of nasals: most anterior point on nasal bones to most posterior point.

Width of nasals: greatest distance across both of them.

Length of audital tube: outer border of foramen ovale to farthest lateral point (with reference to the skull) on zygomatic (or anterior) side of audital tube.

Length of incisive foramina: greatest length of foramen on right side, that is, with skull resting on its dorsal surface and rostrum pointing away from the observer.

Zygomatic width: greatest inclusive measurement, taken outside of the zygomatic arches.

Greatest width of interpterygoid fossa: at expansion of fossa immediately back of hard palate.

Mastoid width of cranium: greatest inclusive measurement taken outside of mastoid processes.

Alveolar length superior cheek teeth: most anterior point on alveolus of premolar four to most posterior point on alveolus of molar three.

Distance between infraorbital foramina: measured on ventral surface of skull.

Mandible, transversely across angular process: greatest dimension along axis of process, nearly at right angles to axis of mandible itself.

Greatest length of mandible: most posterior point on articular condyle of mandible to most anterior point on alveolus of incisor.

External measurements are ordinarily taken as given below. The short and well-haired tail of *Aplodontia* makes the determination of the total length a matter of some difficulty, in consequence of which this measurement has sometimes been taken on the skinned body instead of as specified below.

Total length, on unskinned body stretched out lengthwise, most anterior point on cartilage of nose to tip of tail, exclusive of hairs.

Hind foot, heel to tip of longest claw.

B. VARIATION IN *APLODONTIA*

1. Age Variation

As the aplodontia grow older the soft gray pelage of the young animal becomes less soft and more brownish or blackish, a ventral brown wash may appear in the adult though seldom in evidence in the young, and the numerous white-tipped hairs which stand out so conspicuously in the pelage of the juvenal become obscured. That specific differentiation takes place early is indicated in several of the subspecies, in none more strikingly, however, than in *Aplodontia rufa nigra*, in which the black coloration of the adult is noted in animals of the year taken in July.

The following tendencies may be observed in the crania as maturity approaches. In dorsal view (pl. 25) all the sutures but those bounding the nasal bones laterally tend to disappear; the interorbital constriction tends to grow narrower, proportionally and absolutely; the temporal lines or ridges become accentuated and approach one another, though never, apparently, forming a true sagittal crest (the degree of their approach is different in different species); the mastoid processes tend to grow laterad more rapidly than do the audital tubes; the lambdoidal ridge undergoes marked development; the skull becomes more flat, less round, changing from the more squirrel-like form of early youth to the more specialized *Aplodontia* type of full maturity; all processes become accentuated, and the angular process of the mandible undergoes a considerable transverse expansion, its development proceeding at such a rate that the width of the mandible, measured along the axis of this process, increases faster proportionally than does the length of the mandible. Through all these changes the distance anteriorly across the palate between the alveoli of the fourth premolars remains practically constant.

The permanent teeth are long-crowned and as soon as they become somewhat worn afford no clue to age. The tooth formula of *Aplodontia* is $\frac{1}{1}+\frac{0}{0}+\frac{3}{2}+\frac{3}{3}\times 2=22$. Tooth eruption in available specimens is as follows: Superior, milk P^3, milk P^4, M^1, M^2, M^3, permanent P^3, permanent P^4; inferior, milk P_4, M_1, M_2, M_3, permanent P_4.

The fourth premolars (P^4, P_4), are somewhat less specialized in the deciduous dentition than in the permanent. They are brachyodont, somewhat tuberculated, and have deep enamel lakes, in the former; hypsodont, with tuberculation obscure, and with shallower enamel lakes, all trace of which is soon lost by wear, in the latter.

The considerable variation in size of cranium, as well as in the weight of its bars and processes, noticeable in series of fully adult skulls from the same general locality, indicates that slow growth may continue throughout life.

2. Sexual Differences

Aside from a not well-marked tendency toward larger measurements on the part of the males (which, in specimens of *Aplodontia rufa phaca* measured, average eight per cent longer than the females), and the presence of a series of conspicuous ventral markings about the mammae of summer females, practically no differences due to sex can be made out externally. There are in this genus three pairs of mammae. About each, in females in summer pelage, is a nearly circular area of black or dark brown hair ten to twenty millimeters in diameter, which stands out in strong contrast to the grayish or weakly brownish coloration of the underparts. In males and in winter females the "spot marks" are inconspicuous or lacking.

It would be difficult, if not impossible, to determine the sex of the individual in any given instance by study of the cranium. There is a tendency for ridges and processes to be somewhat more accentuated in the males, for zygomatic arches to be somewhat heavier, and for the temporal ridges to be more closely approximated. Usually the males have basilar length, zygomatic width, mastoid width, and distance transversely across the angular process of the mandible greater than in the females. The largest, heaviest specimens in any adequate series of skulls are usually those of males. In *Aplodontia rufa olympica* the range of variation in size is greater, on the basis of the specimens measured, in the males than in the females. In certain forms the females have the alveolar length of the superior cheek teeth greater than in the males, though the measurements of the latter may exceed those of the former in most respects. In at least two forms, on the basis of measurements taken, the females have interpterygoid fossae averaging broader than in the males. In practically all instances, however, the range of individual variation is so great as to transcend that due to sex.

3. Individual Variation

While in the present study it has been impossible to eliminate geographic, sex, and age variation altogether, still it is believed that the observations, measurements, and percentages given are of value, since they suggest the range of variation, chiefly individual, which must be reckoned with in using a typical series of adults in specific comparisons.

In a series of eleven specimens of *Aplodontia rufa pacifica* taken in February, March and April, there is but little variation in color. Dorsally and laterally all are grizzled pinkish cinnamon, with the brown coloration a little more intense in certain specimens, a little less so in others. The brown wash ventrally varies from near light pinkish cinnamon to pinkish buff. A little more variation, however, is apparent in twelve examples taken during October, November and December. The dorsal coloration in these varies from cinnamon or sayal brown to pinkish cinnamon or light pinkish cinnamon. The pelage of one specimen (no. 9077, Field Mus. Nat. Hist.) is in very poor condition, suggesting that its aberrant paleness may be due to disease. As with the early spring examples, the uniformity of this late fall series of skins is more noteworthy than the variation observed.

Total length and length of tail vertebrae in this genus, as recorded by the collector, are often unreliable. This follows from the fact that the condition of the tail, which is very short but well-haired, makes accurate measurement of tail vertebrae difficult. The writer has, therefore, put the emphasis in this discussion on the more reliable cranial measurements.

In rodent species with hypsodont teeth the age of adults is determinable not at all or only with difficulty. In such species reliance

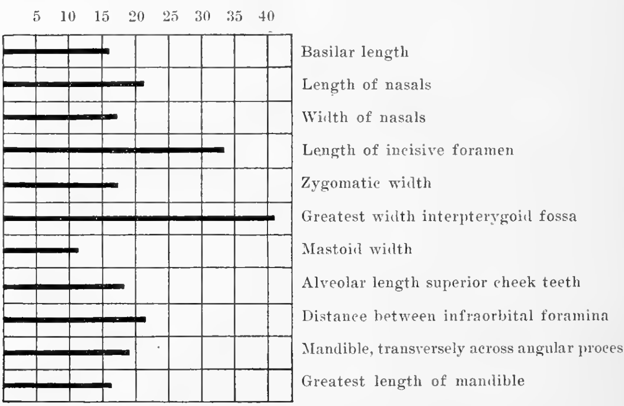
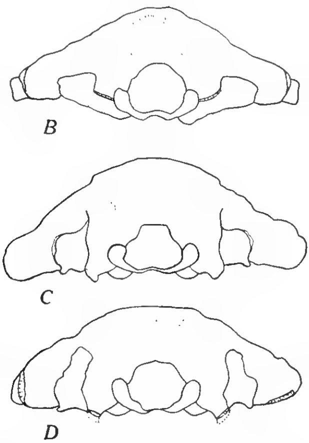


Fig. A. Diagram showing the percentage range of variation (figured on the mean) in cranial measurements of twenty-three skulls of *Aplodontia rufa pacifica* (see table of measurements page 468).

must be placed on the condition of the sutures, the outline of certain bones, the form of the skull, and the development of ridges and processes. It follows that it is possible that an observed range in variation assumed to be individual may really be due to age; and this point ought to be kept in mind through the following discussion.

The diagram (text-fig. A) illustrative of the percentage range of variation shows that for specific comparisons the basilar length, length of nasals, width of nasals, mastoid width, and the width of the mandible, transversely across angular process, are the most dependable characters. Zygomatic width and alveolar length superior cheek teeth are subject to greater variation, while the length of the incisive foramina, greatest width of interpterygoid fossa, and distance between infraorbital foramina are subject to a considerable range of variation. It is doubtless not an accident that the measurements which, in the nature of the case, can be taken with greatest precision, as basilar length and mastoid width, appear to be subject to less variation than those which are more difficult to take with entire accuracy.

The outline of the nasals is fairly uniform in the entire series, the small variation observable being in the condition of the shallow embayment in the lateral outline of the nasals posteriorly, and in their relative breadth anteriorly and posteriorly. The width of the inter-



Figs. B–D. Posterior view crania of *Aplodontia rufa pacifica*, to illustrate variation in relation of parts. × 1. Fig. B, no. 89309, Biol. Surv. Coll.; fig. C, no. 9052, Field Mus. Nat. Hist.; fig. D, no. 77371, Biol. Surv. Coll.

orbital constriction is highly variable, not only in animals of different ages, but also in animals of apparently similar age. In certain specimens a little rounded notch is developed in the lachrymal region, on the anterior border of the orbit. In others, this notch is feebly developed or lacking entirely. The degree of development and approach of the temporal lines or ridges is variable. In some specimens the ridges are weakly developed and comparatively far apart, in others strongly developed and much closer together. The weight of the zygomatic arch is often different in animals of apparently the same age. The arches are bowed outward more in some specimens than in others. The postzygomatic notch is variable. The degree of development of the lambdoidal crest varies in animals of apparently comparable age, being accentuated in certain specimens and setting off a considerable fossa anterior to it, but in others being comparatively weakly developed.

Perhaps the most variable of the cranial characters are furnished by the bones on the posterior aspect of the skull (see text figs. B, C, D). In the adult, the sutures between the exoccipitals, supraoccipital, and the basioccipital have completely disappeared. The paroccipital process and the occipital condyle belong to the exoccipitals. The substance of the mastoid process, as viewed on the posterior aspect of the cranium, results from the ankylosis of two elements, one, the inner, from the exoccipital, and the other, the outer, from the squamosal. A plate from the latter bone invades the outline of the mastoid process from below, and is marked off by prominent sutures in animals of every age. The degree of expansion of the winglike mastoids, the degree of development of the paroccipital processes, and particularly the degree of invasion of the plate of the squamosal which comes up from below, are subject to variation, the wide range of which suggests that it may be due to age. Individual differences are observable in the outline of the foramen magnum, which is rounder in some specimens, flatter in others. In the ventral aspect of the skull one notes that there is considerable variation in the diameter of the third upper premolar, and noticeable variation in the outline of the hamular processes, the length of the incisive foramina, the outline of the interpterygoid fossa, the outline of the zygomatic arch particularly posteriorly, the caliber of the audital tubes and the degree of expansion and development of the paroccipital processes. The relations of the foramina in the regions of the foramen lacerum medium are subject to much variation.

Looking at the skulls in their anterior aspect it is of interest to note the variation in size of the infraorbital foramen, which in its greatest diameter, ranges, in different specimens, from about 2.6 to 4.0 millimeters.

The outline of the coronoid process of the mandible varies from a form in which it is scarcely hooked backward at all, to one in which the hook form is prominent. The mass and outline of the condylar process undergo considerable change from one individual extreme to the other. The inner and outer prominences of the broad angular process of the jaw are differently outlined in different specimens, and the ridge extending from the inner prominence of the angular process exteriorly on the jaw to bound the masseteric fossa anteriorly is comparatively well developed in certain specimens, whereas in others it is interrupted by a smooth space.

4. Molt and Seasonal Variation

There is but one molt annually in *Aplodontia*. Pelage renewal begins in July and August, rarely as early as June, and continues for two or three months. There is no hard and fast manner of molting. The hair usually begins coming in on the sides posteriorly and on the back of the head and neck about the same time. From these centers the molt spreads until the new pelage covers the body, the hair of the shoulders and rump being the last to be renewed dorsally. In some examples the molt proceeds somewhat irregularly. The molt of the underparts lags behind that of the upperparts. Additional details as to molt are mentioned in the accounts of species and subspecies.

The new pelage is longer and sometimes slightly different in coloration from the worn pelage it replaces. Thus in *Aplodontia rufa pacifica*, the fresh pelage is more richly colored than the worn pelage; in *A. r. californica*, it is a trifle browner; and in *A. r. phaea*, it is a little more intensely colored. Differences in coloration and general appearance are small, however, and in several forms of *Aplodontia*, as at present represented in the collections examined, cannot be shown to exist at all.

5. Geographic Variation

Geographic variation, like time variation, is comparatively slight in the genus *Aplodontia*. The forms are so little differentiated that variation geographically is often obscured by individual variation. All of the described forms may with entire propriety be referred to a single species.

Mountain forms are larger as a rule than nearby lowland or coastal forms. Thus *Aplodontia rufa columbiana* of the mountains of Hope District, British Columbia, tends to be larger than *A. r. rufa* of the Puget Sound region; in like manner *rainieri* from Mount

Rainier, Washington, averages larger than *rufa;* and *californica,* inhabiting the Canadian zone of the Sierra Nevada-Cascade mountain system in California, is considerably larger than *phaea,* found in the coastal Marin County near San Francisco Bay. Although this tendency toward variation in size is slight, its apparently uniform association with difference in altitude or life-zone indicates its possible significance.

It has been considered (C. Hart Merriam, 1899*a,* p. 21; Taylor, 1916*c,* p. 501) that the "mountain top" subspecies of *Aplodontia* (*columbiana, rainieri, californica*) are more closely related to each other than to any other forms of the genus. This is possibly true of *columbiana* and *rainieri* (see pl. 28), but the balance of the evidence, as derived from the present study of *rainieri* and *californica,* favors rather the view that these mountain subspecies are more closely related to lowland or neighboring forms than to each other. Their general similarity in size and certain other characters would seem to be due to parallelism.

Geographic isolation appears to be intimately associated with speciation in the group. Although material at hand is not sufficient to demonstrate each step in the process, it is enough to suggest that the ranges of all the described subspecies of *rufa.* except *nigra* and *phaea,* inosculate at one point or another. Geographic variation is continuous, though slight and very gradual, in the intergrading forms. The most strikingly colored form is the apparently completely isolated *Aplodontia rufa nigra* of Point Arena, California.

It is to be noted that whereas on the northern coast of California three well-marked forms of *Aplodontia* are found, on a longer coastline in the state of Oregon there occurs but one. The three communities of *Aplodontia* on the coast of northern California are separated from each other by considerable gaps, while along the coast of Oregon the animals appear to be continuously distributed.

It seems to the writer that the geographical distribution of the different subspecies of *Aplodontia,* as well as the degree of development and nature of the characters separating them, indicate that among the factors possibly concerned in their differentiation, geographic isolation is, at least, one of the most important.

C. HISTORY OF THE APLODONTIIDAE

1. General Remarks

This family is exclusively North American in origin, development, and present distribution. In the absence of any other evidence of European relationship it is probable that the resemblances noted between the American Oligocene aplodontid genus *Allomys* and the genus *Sciurodon* of the European Oligocene (see Schlosser, 1884, pp. 73, 136) are indicative of accidental convergence rather than real relationship.

The earliest aplodontid genius is *Allomys* Marsh (1877, p. 253) or *Meniscomys* Cope (1878, p. 5). Found typically in the Oligocene deposits of the Middle John Day in Oregon, there is only a single record, so far as known to the writer, of its occurrence elsewhere, that of Matthew (1904, p. 263), who has recovered an undetermined species from the Lower Miocene of South Dakota.

The members of the genus *Allomys* were small, ranging from one-half to two-thirds the size of Recent *Aplodontia*. They were much more squirrel-like than is the Recent genus.

Founded upon a single specimen, an imperfect cranium without lower jaws, taken in the gravels and tuffs at the top of the Upper John Day, *Mylagaulodon* is one of the most interesting of the genera which are associated with the Aplodontiidae. The characters of the fourth premolar and infraorbital region of this genus are regarded as demonstrating its aplodontid position.*

The earliest known fossil remains of the genus *Aplodontia* were found by parties from the University of California in the Virgin Valley Miocene and Thousand Creek Pliocene of northern Humboldt County, Nevada. The species there recovered is known as *Aplodontia alexandrae* Furlong (1910, pp. 397–403). It is somewhat smaller than the Recent members of the genus, and differs from them in several particulars, the most important being the relative position of the prominent style internally on the lower molars. For all that, one is impressed with the resemblances rather than the differences between the Tertiary *Aplodontia alexandrae* and the Recent species of the genus.

Another species of *Aplodontia* has recently been described by Dr. J. C. Merriam (1916, pp. 177–179) from the Cedar Mountain region of western Nevada. The formation in which the specimen (a single upper premolar four, somewhat broken) was found has been referred to the Upper Miocene (*loc. cit.*, p. 171), the Cedar Mountain fauna being regarded as intervening in time between the Mascall Middle Miocene of the Middle Basin area and the Barstow Upper Miocene of the Mohave area.

That both *Aplodontia alexandrae* and the Cedar Mountain species represent advanced stages of development between *Allomys* and *Aplodontia* seems clear. Both are nearer *Aplodontia* than *Allomys;* but neither one is so specialized as are the Recent forms of *Aplodontia.*

There remains to be considered only *Aplodontia major fossilis* Sinclair (1905, pp. 147–148), discovered in 1902 by an expedition from the University of California, in the Pleistocene Potter Creek Cave, Shasta County, California. Comparison of the numerous remains of this species in the University of California Collections in Vertebrate Palaeontology with a large series of skulls and jaws of *Aplodontia rufa californica*, the Recent form occurring in the same general region, shows that the Pleistocene form is very doubtfully if at all distinguishable from the living species.

2. Summary and Discussion

It is worthy of remark that nearly all of the records of extinct members of the family Aplodontiidae are from the now arid territory east of the great Cascade-Sierra mountain system, which system, at the present time, marks the eastern boundary of the range of the genus (see map, text-fig. E). The members of the chiefly Oligocene genus *Allomys* hail from the John Day Beds of eastern Oregon, with one outlying undetermined species in the Rosebud Lower Miocene of South Dakota; *Mylagaulodon* comes from the top of the Upper John Day in eastern Oregon; *Aplodontia alexandrae* occurs in the arid Virgin Valley and Thousand Creek beds of northern Humboldt County, Nevada; an *Aplodontia* of an unnamed new species comes from the Cedar Mountain region of western Nevada; and only *Aplodontia major fossilis,* found in the Pleistocene Potter Creek and Samwel caves, in the Shasta region of northern California, comes from the Pacific slope of the Sierran system. Apparently the range of the family Aplodontiidae, as well as of the genus *Aplodontia,* was formerly much greater than at present, though it must be conceded that very little is known of the precise relationships of the early aplodontids to the Recent genus, and we have little data on the westward range of members of the family in Tertiary time.

Reference has already been made to the conservatism of the aplodontid phylum. If, as seems highly probable, *Aplodontia alexandrae* is near the direct line of descent of the recent species, it is noteworthy that, during a lapse of time sufficient for the evolution of the horse from the Miocene *Merychippus* type to the larger Pliocene *Pliohippus*, there was no great specific change; and that, during a time which sufficed to transform the short-toothed, small-sized *Merychippus* into the much larger modern *Equus*, with modifications in every bone in the body, and with characters generically probably twice removed, the aplodontid stock has undergone comparatively slight change, all

Fig. E. Continent of North America, to indicate present range of genus *Aplodontia*, and apparent extension of range of family Aplodontiidae in Tertiary times.

Cross-hatched area indicates limits of range of Recent genus; circle represents record of fossil genera *Allomys* and *Mylagaulodon*; triangle indicates an additional record of *Allomys*; squares indicate records of genus *Aplodontia* fossil.

observed variations, as at present recognized, falling within the limits of a single genus.

D. HABITS OF *APLODONTIA*

Aplodontia is herbivorous, colonial, nocturnal, and fossorial. A considerable degree of humidity and an abundant supply of food plants seem to be necessary conditions to its existence. Situations well sheltered by a tangle of vegetation are usually chosen for its burrows. Its nest is made underground, in an enlarged chamber. Attention has been called to a hay-making instinct. The "hay" consists simply of green plants of various kinds cut up and spread out as if to dry and to be used later. Sight and hearing are apparently defective; but smell and touch, particularly the latter, appear to make up for any deficiencies in these respects.

Little is known of the animal's breeding activity. Young have been taken throughout the summer season. It has been asserted that *Aplodontia* has a shrill cry. Among its enemies are weasels, skunks of two genera, wildcats, mink, gray foxes, golden eagles and great horned owls. Other potential enemies are coons, badgers, and fishers.

Although locally *Aplodontia* does some damage to man's interests, its habitat is such that for the most part it is of no economic significance. It burrows holes in ditch walls along the line of the Southern Pacific in the Sierra Nevada in California; in Oregon it undermines government trails, causing them to be washed out; and Lantz (1917, p. 16) reports that in western Washington considerable complaint has been made of their depredations on crops, particularly small fruits. The skins are of little or no value.

The habits of *Aplodontia* have recently been studied by Anthony (1915, pp. 53–63). The most complete paper on this subject to date is that of Mr. Charles Camp, now in press in this series of publications.

E. PRESENT SYSTEMATIC STATUS OF *APLODONTIA*

1. The Family Aplodontiidae

Prensiculantia (part) Minding (1829), p. 86.
Muridae (part), Bonaparte (1831), p. 20.
Sciurina (part), Bonaparte (1831), p. 20.
Cunicularia (part) Wagner (1843), pp. 357, 395.
Pseudostomides (part) Gervais (1854), p. 364.

Saccophoriens (part) Gervais (1854), p. 364.
Sciuroides (part) Brandt (1855), p. 151.
Haploodontini or Prismatodontes Brandt (1855), p. 151.
Sciuridae (part), Baird (1857), pp. 240, 350.
Castorinae (part) Baird (1857), p. 350.
Haploodontidae Lilljeborg (1866), table opp. p. 9.
Haploodontoidea Gill (1872), p. 22.
Haplodontidae Alston (1876), pp. 66, 75, 78.
Haplodontiidae Cope (1883), p. 54.
Aplodontidae Allen (1892), p. 31.
Aplodontiae Thomas (1896), p. 1015.
Aplodontiidae Thomas (1896), p. 1015.
Haplodontoidea Weber (1904), p. 496.
Aplodontoidea Matthew, *in* Osborn (1910), p. 534.

Characterized by Matthew (1910, p. 69) as follows:

"Teeth $\frac{1.0.2.3}{1.0.1.3}$, progressively hypsodont, with prominent mesostyles and metastylids. No postorbital process; zygomatic arch slender; skull wide posteriorly; postero-inferior portion of angle greatly inflected, posterior end everted. Fossorial, Oligocene to recent. Genera, *Aplodontia, Meniscomys* [= *Allomys*], *Mylagaulodon.*"

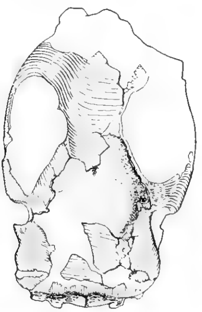


Fig. F

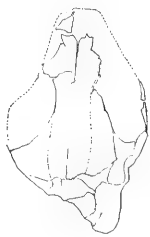


Fig. G

Fig. F. *Allomys liolophus* Cope, dorsal view of cranium. × 1. Univ. Calif. Coll. Vert. Palae., no. 1672; locality 898, John Day Beds, Oregon.

Fig. G. *Allomys cavatus* Cope, dorsal view of cranium. × 1. Univ. Calif. Coll. Vert. Palae., no. 1444; locality 864, John Day Beds, Oregon.

If *Allomys* is to be referred to the family Aplodontiidae a change in the above characterization will be necessary; for postorbital processes are present in specimens of *Allomys liolophus* and *A. cavatus* in the University of California Collections in Vertebrate Palaeontology (see text-figs. F, G).

2. THE GENUS *Aplodontia*

The chief generic characters are as follows: dentition $\frac{1}{1}+\frac{0}{0}+\frac{2}{1}+\frac{3}{3}\times 2=22$; permanent teeth hyposodont, of secondarily simple enamel pattern, characterized by prominent styles internally on the inferior teeth and externally on the superior teeth; cranium greatly depressed; postorbital processes on frontal absent; postorbitals on jugal weakly or not at all developed; infraorbital foramen primitive, not transmitting any part of masseter; angle of mandible remarkably expanded transversely; scaphoid and lunar not separate; fibula not articulating with calcaneum, free from tibia; body stout, about 350 millimeters long; pelage dark; eyes and ears small (pl. 29); mammae six; tail very short; nocturnal, fossorial, found in restricted area in western North America.

The much modified hyposodont teeth, the depressed skull, the absence of postorbital processes (pls. 26, 27), the extraordinarily inflected angle of the mandible, the fusion of the scaphoid and lunar into a single bone, the proportionate enlargement of the forefeet (for digging), and probably also the smallness of eyes and ears, are suggestive of a high degree of specialization in *Aplodontia*. On the other hand the simplicity of the dental formula and the characters of the infraorbital region (pl. 27) show a generalized or primitive condition. The infraorbital foramen is moderate in size, and does not transmit any portion of the masseter, the origin of which, according to Matthew (1910, p. 69), is wholly behind and below the lower margin of the orbit, and not extended forward on the side of the muzzle.

3. VARIATIONS IN THE GENERIC NAME

Palmer (1904, pp. 24, 25) has called attention to the fact that the name *Aplodontia* is capable of twenty-four modifications, each one progressively differing from the next by a single letter. That several of these possible spellings of the name have found place in literature is indicated by the following list of names applied to the genus:

Anisonyx (part) Rafinesque (1817), p. 45.
Anisonix (part) Minding (1829), p. 86.
Aplodontia Richardson (1829*a*), pp. 333–337.
Apludontia Fischer (1830), p. 398 (error for 598).
Haplodon Wagler (1830), pp. 4, 22.

Arctomys (part), Douglas (1914), pp. 59, 156.
Apluodontia Richardson (1837), p. 150.
Aplodontie Gervais (1854), p. 364.
Haploodon and Hapludon Brandt (1855), p. 150, footnote.
Haploödon, Haploudon, Haploödus, Haplodus, Haploudus Coues (1877*b*), p. 556.
Haplodonta Cope (1883), p. 55.
Hapludus, Aploudontia, Haploudontia Coues (1890), p. 2712.
Haplodontia Elliot (1899), pp. 241–276.
Aploodontia, Aplodon, Aploodon, Aploudon, Apludon, Aplodus, Aploodus, Aploudus, Apludus, Haploodontia, Hapludontia Palmer (1904), p. 25.

There has been no agreement as to a vernacular name for aplodontia. Among names applied to the animal are found the following: Mountain beaver, mountain boomer, gehalis, and farmer; giant mole, mammoth mole, ground bear, marmot, ground hog, woodchuck, gopher, badger, muskrat, blue muskrat, high ground muskrat, and (Indian names) sewelel, shewelel, sewewel, or sewellel, showhurll, showhurtl, showtl, showt'l, show'tl, shote, squallah, swak-la, o-gwal-lal, and ou-ka-la. I am indebted to Dr. C. Hart Merriam for the following list of names given aplodontia by certain tribes of Californian Indians:

Name	Tribe	Locality
Ne-ta-te	Tolowa or Huss	Crescent City
Mah-pe-neetch	Karok	Happy Camp to Weitzpek
Tabt-ka-wer-itl	Soo-lah-te-luk	Humboldt Bay
Waw-kaw-see	Mo-des-se	Pit River
Yah-sah	Nis-se-nan	Colfax and Placerville to Yuba
Wes-skap[c]	Yurok	Lower Klamath; mouth of river to Weitzpek

4. List of Species and Subspecies with Type Localities

Aplodontia rufa rufa (Rafinesque). "Neighborhood of the Columbia River"; specimens from Marmot, Clackamas County, Oregon, regarded as typical. (p. 454)

Aplodontia rufa olympica Merriam, C. H. Quiniault Lake, Chehalis County, Washington. (p. 460)

Aplodontia rufa columbiana Taylor. Roab's Ranch, near Hope, British Columbia. (p. 463)

Aplodontia rufa rainieri Merriam, C. H. Paradise Creek, south side of Mount Rainier, Washington. (p. 465)

Aplodontia rufa pacifica Merriam, C. H. Newport, mouth of Yaquina Bay, Lincoln County, Oregon. (p. 467)

Aplodontia rufa humboldtiana Taylor. Carlotta, Humboldt County, California. (p. 470)

Aplodontia rufa californica Peters. The mountains of California; assumed to be the Sierra Nevada; specimens from Blue Canyon regarded as typical.
(p. 473)

Aplodontia rufa nigra Taylor. Point Arena, Mendocino County, California.
(p. 479)

Aplodontia rufa phaea Merriam, C. H. Point Reyes, Marin County, California.
(p. 480)

5. Accounts of Species

Aplodontia rufa rufa (Rafinesque)

Brown Aplodontia

Sewellel Lewis and Clark (1814), p. 176.
Sewewell [=*Sewellel*] Lesson (1827), p. 240.
Ground Rat Douglas (1836), p. 101.
Arctomys brachyurus? Douglas (1836), p. 101.
Anisonyx? rufa Rafinesque (1817), p. 45.
Anisonyx? rousse Desmarest (1822), p. 330.
''*Anisonix rufa?*'' Minding (1829), p. 86.
Arctomys rufa, Harlan (1825), pp. 308–309.
Anisonyx roux Lesson (1827), p. 240.
Aplodontia leporina Richardson (1829*a*), pp. 333–337.
Apludontia leporina, Fischer (1830), p. 398 [=error for 598].
H[*aplodon*]. *leporinus* Wagler (1830), p. 22.
Apluodontia leporina Richardson (1837), p. 150.
Aplodontie léporine Gervais (1854), p. 364.
H[*aploodon*]. *leporinus,* Lilljeborg (1866), p. 41.
Haplodon rufus Coues (1877*b*), p. 557.
Haplodonta rufa, Cope (1883), p. 55.
Aplodontia rufa, Merriam (1886), pp. 312–328.
A[*plodontia*]. *rufus,* Price (1894), p. 328.
Aplodontia major (part) Merriam (1897), p. 219.
H[*aplodontia*]. *rufa,* Elliot (1899), p. 251.
Aplodontia chryseola Kellogg (1914), pp. 295–296.
Aplodontia rufa grisea Taylor (1916*c*), pp. 497–499.

Type Locality.—It is well known that Rafinesque's description of ''*Anisonyx? rufa*'' was based entirely upon the Sewellel of Lewis and Clark. As cited by Rafinesque the type locality is the ''neighborhood of the Columbia River.'' It is now known that two subspecies of *Aplodontia* occur on the Columbia River. The coastal form described as *Aplodontia pacifica* is found at Astoria, while an inland form commonly known as *A. rufa* occurs in the foothill country about Mount Hood. The original description of *rufa* is not diagnostic as between the coastal and the inland forms. Doubtless Lewis and Clark saw Indian robes made from the skins of both. There would be no advantage in transferring the name *rufa* to the well known form *pacifica*. It seems altogether appropriate, on the other hand, that the name *rufa* be fixed on the inland race, of which specimens collected at Marmot, Clackamas County, Oregon (western slope of Mount Hood, not far from the Columbia River), may be regarded as typical.

Specimens Examined.—Total number, 135, from the following localities:

British Columbia: New Westminster Provincial District—Chilliwack, 5; Sumas, 1; Mt. Baker Range, 1.

Washington: Skagit County—Sauk, 8 (1 skull only); Hamilton, 1; Mt. Vernon, 5 (2 skulls only). King County—Seattle, 6 (one is skull and skeleton only); Ravenna, near Seattle, 1; Renton, near Seattle, 3; Kirkland, 6; "Puget Sound"?, 2. Kittitas County—Easton, 8. Pierce County—Puyallup, 2.

Oregon: Clackamas County—Marmot, 6 (2 skulls only); Eagle Creek, eight miles southeast of Bissell, 1; Bissell, 1; head of Eagle Creek, 1; "Clackamas County," 1 (no skull). Lane County—Vida, 6; McKenzie Bridge, 3; Horse Pasture Mt., ten miles by road southeast of McKenzie Bridge, 3; O'Leary Mt., ten miles by road southeast of McKenzie Bridge, 1. Jackson County—Siskiyou, 20; north base Ashland Peak (alt. 5,200 ft.), 2. Klamath County—Mt. Mazama, Anna Creek (alt. 6,000 ft.), 3; Fort Klamath, Anna Creek Canyon, 3.

California: Siskiyou County—Siskiyou Mts., White Mt. (alt. 6,000 ft.), 8; Siskiyou Mts., Craigy Peak (alt. 6,200 ft.), 1; Siskiyou Mts., Studhorse Canyon (alt. 6,500 ft.), 1; Trinity Mts., east of Hoopa, ten miles west of Forks of Salmon (alt. 5700–5,800 ft.), 5; Salmon Mts., Etna Mills, 3; Salmon Mts., Jackson Lake, 5; Salmon Mts., Wild Cat Peak, 1; Salmon Mts., South Fork of Salmon River, 1. Trinity County—Canyon Creek, 5; Salmon

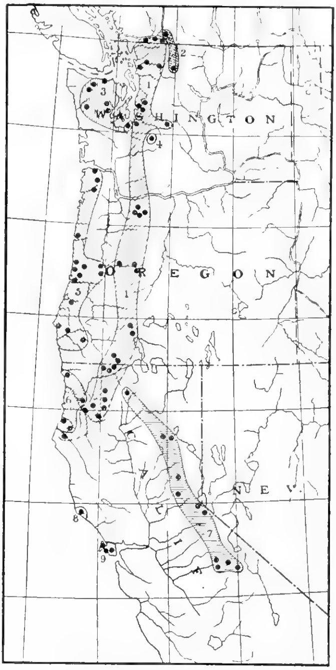


Fig. H. Geographic distribution of the nine recognized races of the genus *Aplodontia*.

1. *Aplodontia rufa rufa*
2. *Aplodontia rufa columbiana*
3. *Aplodontia rufa olympica*
4. *Aplodontia rufa rainieri*
5. *Aplodontia rufa pacifica*
6. *Aplodontia rufa humboldtiana*
7. *Aplodontia rufa californica*
8. *Aplodontia rufa nigra*
9. *Aplodontia rufa phaea*

Mts., head of Grizzly Creek, 3. Humboldt County—"Northwest California" [Hoopa Valley], 2 (no skulls); Rio Dell, 1.

Geographic Range.—Neighborhood of the Columbia River, in western Oregon, interiorly on the Pacific side of the Cascades; thence southward in a belt of unknown width to Mount Mazama in southern Oregon and the Siskiyou-Trinity district in northern California; northward to Puget Sound and the Chilliwack-Sumas region in southwestern British Columbia. Altitudinal range, from sea level in the Puget Sound district to 6,500 feet in the Siskiyou-Trinity Mountains of northern California; zonal range, Transition and Canadian.

Cranial Characters.—Skulls moderate (see measurements below), nasals variable in outline, broad anteriorly, but usually much narrowed at their posterior ends; rostrum short; audital tubes in typical material tending to be of greater caliber than in other forms of the genus, about as in *californica* (see Remarks, below).

External Characters.—Above, in specimens taken at all seasons, light ochraceous-buff (Ridgway, *Color Standards and Color Nomenclature,* 1912), in some specimens grading anteriorly into light buff, vinaceous-cinnamon or even occasionally approaching tawny; some with a distinctly grayish, others a distinctly brownish cast of coloration; some examples paler anteriorly and grayer posteriorly, with deepest coloration in middle region of body; grizzled with more or fewer blackish hairs; white spot at base of ear; some silvery-white hairs insprinkled, particularly posteriorly. Below, grayish, with the faintest possible wash of brownish of a hue near pinkish buff, or brownish, with a conspicuous wash of vinaceous-cinnamon or light vinaceous-cinnamon, and with scattered black hairs insprinkled; practically all hues between these are observable; drab-gray basal coloration showing through to a greater or less degree; spot-marks about mammae in spring and fall females seal brown or paler in coloration.

Molt and Seasonal Change.—That *Aplodontia rufa rufa* molts once, that the pelage renewal takes place during the late summer and the fall, and that a term of from two to three months is required for the completion of the molt, is suggested by the following facts: Specimens taken May 17, June 5, 22, 23, and July 22 and 23, and even two exceptional specimens taken August 26 and September 13, are much worn but show no sign of molt. On the other hand, molt has already begun in other specimens of *rufa* taken on June 23 and 24, and pelage renewal is going on in practically all specimens taken during August, September and October. Examples secured September 29 and October 9, respectively, show the last stages of the process; and the molt is entirely completed in a specimen taken November 21. Evidently August, September and October are the principal months of molt.

Seasonal changes are trifling. The fresh pelage is longer and tends to be somewhat browner, sometimes blacker, than in its hold-over stage in spring and early summer.

Cranial Measurements of *Aplodontia rufa rufa* (13 Skulls) From Marmot, Vida and Vicinity of McKenzie Bridge, Oregon

	Average	Mean	Maximum	Minimum
Basilar length	59.1	59.1	61.1	57.2
Length of nasals (10 skulls)	25.2	25.1	27.3	23.0
Width of nasals	12.3	12.4	13.3	11.5
Length of audital tube (10 skulls)	18.9	18.5	21.0	16.0
Length of incisive foramen	6.6	7.2	8.7	5.7
Zygomatic width	55.5	54.5	59.6	49.5
Mastoid width of cranium	53.3	53.2	59.0	47.4
Alveolar length superior cheek teeth	18.8	19.0	19.9	18.2
Distance between infraorbital formamina	16.6	16.4	17.8	15.0
Mandible, transversely across angular process	23.1	22.4	25.0	19.9
Mandible, greatest length (12 skulls)	46.2	46.0	48.7	43.3

External Measurements of *Aplodontia rufa rufa*, From Vida and Vicinity of McKenzie Bridge, Oregon

	Average	Mean	Maximum	Minimum
Total length (9 skins)	345	348	387	310
Hind foot (7 skins)	56	56	59	54

Cranial Measurements of *Aplodontia rufa rufa* (12 Skulls), From the Vicinity of Seattle and Mount Baker Range, Washington, and the Chilliwack-Sumas District, British Columbia

	Average	Mean	Maximum	Minimum
Basilar length	59.6	59.5	62.1	57.0
Length of nasals (10 skulls)	26.1	25.2	27.2	23.2
Width of nasals	11.7	11.5	12.8	10.2
Length of incisive foramen	7.2	7.1	8.1	6.2
Zygomatic width	55.5	54.1	58.9	49.3
Greatest width of interpterygoid fossa	5.0	5.0	5.8	4.2
Mastoid width of cranium	52.2	52.5	55.7	49.4
Alveolar length of superior cheek teeth	19.1	19.1	20.0	18.3
Distance between infraorbital foramina	16.6	16.4	17.6	15.2
Mandible, transversely across angular process	22.6	23.0	25.9	20.2
Mandible, greatest length	47.6	47.3	49.5	45.1

External Measurements of *Aplodontia rufa rufa* (9 Skins), From the Vicinity of Seattle, Washington, and Chilliwack, British Columbia

	Average	Mean	Maximum	Minimum
Total length	331	332	345	318
Hind foot	56	56	58	54

Cranial Measurements of *Aplodontia rufa rufa* (7 Skulls), from Trinity and Siskiyou Counties, California

	Average	Mean	Maximum	Minimum
Basilar length	59.3	59.8	61.8	57.9
Length of nasals (6 skulls)	24.7	24.5	26.2	22.9
Width of nasals	11.7	11.8	13.0	10.7
Length of audital tube	19.1	19.4	21.1	17.7
Length of incisive foramen	7.2	7.2	7.6	6.7
Zygomatic width	56.1	55.9	60.4	51.4
Greatest width of interpterygoid fossa	5.1	5.1	5.3	4.8
Mastoid width of cranium	53.6	54.3	58.2	50.4
Alveolar length superior cheek teeth	18.8	18.7	19.2	18.2
Distance between infraorbital foramina	16.5	16.3	18.2	14.4
Mandible, transversely across angular process	24.0	23.9	26.0	21.7
Mandible, greatest length	48.3	47.7	51.3	44.5

External Measurements of *Aplodontia rufa rufa* (7 Skulls), from Trinity and Siskiyou Counties, California

	Average	Mean	Maximum	Minimum
Total length	340	340	370	310
Hind foot	59	58	63	53

Averages of External Measurements: Four specimens from Easton, Washington: total length, 354 mm. (345–368); hind foot, 59 (58–63). Eighteen specimens from Siskiyou, Oregon: total length, 332 (310–394); hind foot, 58 (52–63). Ten additional examples from the Siskiyou Mountains, California: total length, 349 (320–370); hind foot, 55 (53–58). Two specimens from Ashland Peak, Oregon: total length, 340, 352; hind foot, 60, 63. Two examples from Anna Creek, Mount Mazama: total length, 360, 385; hind foot, 58, 61. Three specimens from Fort Klamath, Anna Creek Canyon: total length, 333, 338, 370; hind foot, 54, 60, 57. Three specimens from Canyon Creek, California: total length, 345, 360, 370; hind foot, 60, 60, 60.

Remarks.—*Aplodontia rufa rufa* is a variable form embracing a number of local forms, some of which, if their extremes only were considered, would certainly rank as good subspecies. The number of these local variants (which have been noted from the Chilliwack-Sumas district, British Columbia; vicinity of Seattle, Puget Sound, Washington; Ashland Peak, Siskiyou and Fort Klamath, Oregon; the Siskiyou Mountains and Canyon Creek, California; and elsewhere), coupled with the great range of individual variation observable in series from the same general locality, make impracticable the recognition of subspecies within the range of *A. r. rufa* as here outlined.

Specimens of *rufa* from the immediate vicinity of Seattle, Washington, tend to have narrower nasals and rostra, mastoid width less, audital tubes of smaller caliber, and fossae set off anteriorly by lambdoidal ridge shallower than in typical material from Marmot, Oregon.

Externally they give a mass effect of grayish rather than brownish as in the Marmot examples. The differences are slight, however, and are not shown to the same extent by examples from nearby localities, as Mount Vernon, Hamilton, Sauk and Easton, in Washington, and the Chilliwack-Sumas district in British Columbia. The form from the vicinity of Seattle was recently described by the writer under the name *Aplodontia rufa grisea* (Taylor, 1916*c*, p. 497), but the examination of considerable additional material indicates the propriety of synonymizing *grisea* under *rufa*.

The effects of varying degrees of local isolation seem to be shown by specimens of *Aplodontia rufa* from the rough and mountainous region embraced in its range in southern Oregon and northern California. Groups of specimens from particular localities, however, do not show the constant differences which would be necessary to entitle them to recognition as subspecies. Examples of *rufa* from the Siskiyou-Trinity region of northern California (recently described by Kellogg, 1914, p. 295, as *Aplodontia chryseola*) tend to have the caliber of the audital tube less than in typical *rufa*, the outline of the external auditory meatus a little flatter, the nasals slightly narrower and shorter, and coloration and quality of pelage slightly different. These tendencies, however, are overshadowed by the magnitude of the individual variation in the series. There appear to be several other local races of *rufa* as well entitled to subspecific recognition as *chryseola*, but if they were to be described, no logical ranges could be given, and the degree of overlapping would make identification of specimens difficult if not impossible.

Intergradation between *Aplodontia rufa rufa* and neighboring subspecies is hinted at or directly demonstrated by specimens examined as follows: Intergradation with *columbiana*, by specimens from Sumas and Chilliwack, British Columbia; with *rainieri*, by examples from Easton, Washington; with *olympica*, by an example from Steilacoom, Washington; with *pacifica*, by specimens from Lane County, Oregon, and from Siskiyou, Oregon; with *californica*, by examples from Mount Mazama, Oregon, and Canyon Creek, California; and with *humboldtiana* by specimens from the divide between the Trinity and Klamath rivers, twelve miles north of Hoopa Post Office, northern California.

A considerable series of specimens from Siskiyou, Oregon, is puzzling, being *pacifica*-like in coloration, but larger, and in certain cranial characters more like *rufa*. As in other series, the range of individual variation is great. Two examples from Siskiyou (nos. 56737, 56738, Biol. Surv. Coll.) are larger than the others of the series and have conspicuously heavier crania. Examples of *rufa* from Ashland Peak, also, are above the average in size, and show a likeness to *rainieri* in certain skull characters.

Intergradation between *rufa* and *californica* is best shown by several examples from Canyon Creek, California. These specimens combine the coloration and shortness of the rostrum of *rufa* with the squarer zygomatic arches and, in one case, the distinctive nasal outline of *californica*.

The distribution of aplodontias in northwestern California will bear additional intensive research. Specimens from the Trinity Mountains, east of Hoopa, are nearly typical of *rufa* from farther inland, although they show a slight tendency cranially in the direction of *humboldtiana*. Real intergradation is indicated, however, by three specimens from the divide between the Klamath and Trinity rivers, twelve miles north of Hoopa Post Office. Of these, an adult female (no. 98745, Biol. Surv. Coll.) both in cranial and external characters resembles *humboldtiana;* one young animal also (no. 97291, Biol. Surv. Coll.) resembles *humboldtiana;* while the third (no. 97290, Biol. Surv. Coll.), also a young animal, is nearest *rufa*. Examples referred to *rufa* have been taken in Hoopa Valley, as well as at Rio Dell, Humboldt County, California.

A tendency toward pattern formation is noted in specimens from Sauk, Washington. Extensive irregular patches of white beneath are conspicuous in several examples.

Aplodontia rufa olympica Merriam

Olympic Aplodontia

Aplodontia olympica Merriam (1899), p. 20.
Haplodontia olympica, Elliot (1899), pp. 251–253.

Type.—Male, young adult, no. 89549, U. S. Nat. Mus., Biol. Surv. Coll.; Quiniault Lake, Olympic Mountains, Washington; July 24, 1897; collected by R. T. Young; orig. no. 309; stuffed skin, with skull and jaws, all in good condition.

Specimens Examined.—Total number 29, from the following localities:

Washington: Pierce County—Fort Steilacoom, 1; Steilacoom, 1 (skull only). Clallam County—Happy Lake, Olympic Mts., 6; Olympic Mts., near head of Soleduc River (alt. 4500 ft.), 1; Port Angeles, 3. Jefferson County—Olympic Mts., head of north fork of Skokomish River, 2. Chehalis County—Quiniault Lake, 8. Mason County—Lake Cushman, 5; "Mason County," 2 (odd skulls).

Geographic Range.—Northwestern Washington, vicinity of Olympic Mountains, intergrading with *Aplodontia rufa rufa* in the vicinity of Steilacoom, southern Puget Sound.

Cranial Characters.—Skull moderate in size (see measurements below); nasals tending to be somewhat variable in outline; temporal lines or ridges tending to be more closely approximated anteriorly than in *rufa;* zygomatic arches tending to be lighter in weight than in *rufa;* thirteen out of seventeen crania examined with prominent postorbital process on the jugals, a character not developed to the same degree in any other form of *Aplodontia;* audital tubes tending to be of smaller caliber than in typical *rufa;* notch on upper side of external auditory meatus smaller and narrower than in typical *rufa.*

External Characters.—Above, in summer specimens, pinkish cinnamon to light ochraceous-buff, often with something of a grayish cast; the whole grizzled with more or less of an admixture of black hairs; head and face brownish or grayish; under parts grayish with a faint wash of pinkish buff or cinnamon buff.

Sexual Differences.—No appreciable external differences due to sex have been observed except in respect to the spot markings of the mammae and possibly a slight pallor ventrally in females.

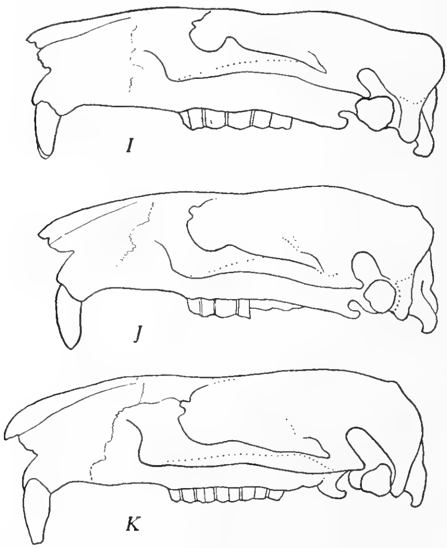
Cranial Measurements of *Aplodontia rufa olympica* (17 Skulls)

	Average	Mean	Maximum	Minimum
Basilar length	59.3	60.2	63.0	57.4
Length of nasals (12 skulls)	26.4	26.9	28.9	24.9
Width of nasals	11.9	12.1	13.3	10.8
Length of audital tube (12 skulls)	18.9	19.1	20.0	18.1
Length of incisive foramen	7.0	7.2	8.0	6.4
Zygomatic width (15 skulls)	54.6	54.9	56.9	52.8
Greatest width of interpterygoid fossa (12 skulls)	5.2	5.2	6.0	4.4
Mastoid width of cranium (16 skulls)	53.0	52.8	55.9	49.7
Alveolar length of superior cheek teeth	19.3	19.4	20.2	18.5
Distance between infraorbital foramina	16.5	16.4	17.5	15.3
Mandible, transversely across angular process	23.3	23.5	25.2	21.9
Mandible, greatest length	47.1	46.8	49.7	43.8

External Measurements of *Aplodontia rufa olympica* (10 Skins)

	Average	Mean	Maximum	Minimum
Total length	355	353	367	340
Hind foot	49	47	59	36

Molt and Seasonal Change.—The only months represented by available specimens of *olympica* are July and August. In the series at hand the molt begins about the middle of July, and is not completed till September at the earliest. One example (no. 67615, ♀, U. S. Nat. Mus., Biol. Surv. Coll.), secured August 17, is exceptional in that even at that late date it shows no sign of molt. On the basis of specimens at hand the winter coat is a little browner than the summer pelage.



Figs. I–K. Side view of crania of *Aplodontia rufa olympica*, to illustrate variation in development of postorbital process of the jugal. × 1. Fig. I, no. 66229, Biol. Surv. Coll.; fig. J, no. 6314, Field Mus. Nat. Hist.; fig. K, no. 89549, Biol. Surv. Coll.

Remarks.—*Aplodontia rufa olympica* is a feebly marked race of the *rufa* series occurring in the Olympic Mountain district of Washington, and grading insensibly into *rufa* to the east and southeast. Additional material from scattered localities in western and northwestern Washington may demonstrate so great a degree of variability as to make inadvisable the separate recognition of the Olympic Mountain form. The postorbital process on the jugal, the most important character of the subspecies, is subject to considerable variation (text figs. I, J, K), and is more apparent in specimens from Lake Cushman than in those from Quiniault Lake. Specimens from Steilacoom (no. 2476, U. S. Nat. Mus., skull only) and Fort Steilacoom (no. 278, U. S. Nat. Mus., part of skull inside skin), here referred to *olympica*, might be referred to *rufa* with equal propriety.

Aplodontia rufa columbiana Taylor

Northern Aplodontia

Aplodontia californica columbiana Taylor (1916*c*), pp. 499–501.

Type.—Male adult; no. 1899, Coll. E. A. and O. Bangs, Mus. Comp. Zool.; Roab's Ranch, Hope, British Columbia; June 14, 1894; collected by W. C. Colt; stuffed skin with skull and jaws in good condition, except skin of foreleg injured in trap, and skull with left audital tube, region of foramen magnum, and hamulars, somewhat injured.

Geographic Range.—Vicinity of Hope, British Columbia, south in the Cascade Mountains of Washington; probably intergrading with *Aplodontia rufa rainieri* between the international boundary and Mount Rainier.

Specimens Examined.—Total number 11, from the following localities:

British Columbia: Yale Provincial District—Lake House, near Hope, 4; Roab's Ranch, Hope, 5. Washington: Skagit County—Head of Cascade River, 2.

Cranial Characters.—Skull heavy and large (see measurements below); for example, on basis of tables of measurements, furnishing maximum for the genus in length of nasals, zygomatic width, mastoid width, and greatest length of mandible; averages of length of nasals and zygomatic width exceeding the maximum in any other form; zygomatic arches moderate and, looking down upon them from above, transversely expanded posteriorly; temporal lines or ridges tending to be closely approaching, though never forming a distinct sagittal crest; dorsal outline of skull comparatively straight; audital tubes small calibered, dorso-ventral diameter tending to exceed anteroposterior diameter, tube thus appearing as if pinched anteroposteriorly.

External Characters.—Above, in summer skins, near light pinkish cinnamon, in some specimens as pale as light ochraceous-buff, in others as dark as pinkish cinnamon, grizzled with many blackish and sometimes a few whitish-tipped hairs; number and degree of concentration of black hairs on back variable; underparts showing faint brown wash, sometimes nearer light pinkish cinnamon, sometimes nearer pinkish buff; general undertone of coloration ventrally pale drab-gray, with an insprinkling of varying numbers of blackish, whitish, cinnamon or buffy hairs; irregular areas of hair white from base to tip appearing in most of the males ventrally.

Sexual Differences.—The conspicuous white patches ventrally appear in males only, all the examples of that sex showing them to a greater or less extent. The spot marks about the mammae in May and July females are less conspicuous than usual. Of two females taken in July, one (no. 1894, Mus. Comp. Zool.) has the hair about the mammae practically worn off, while the other (no. 1895, Mus. Comp. Zool.) has the hair in the same region unworn. It seems likely that the condition of the hair about the mammae may be taken as an index to breeding activity.

CRANIAL MEASUREMENTS OF *Aplodontia rufa columbiana* (9 SKULLS)

	Average	Mean	Maximum	Minimum
Length of nasals (7 skulls)	29.3	29.5	30.9	28.2
Width of nasals	12.8	12.9	13.8	12.0
Length of incisive foramen	8.0	7.8	8.5	7.2
Zygomatic width	62.3	60.9	64.0	57.9
Mastoid width of cranium	57.5	57.2	61.2	53.2
Alveolar length superior cheek teeth	19.3	19.3	19.8	18.8
Distance between infraorbital foramina	16.9	17.2	18.3	16.2
Mandible, transversely across angular process	24.6	24.5	26.1	23.0
Mandible, greatest length	51.2	51.9	54.9	48.9

EXTERNAL MEASUREMENTS OF *Aplodontia rufa columbiana* (9 SKINS)

	Average	Mean	Maximum	Minimum
Total length	427	425	470	380

Remarks.—Available material indicates intergradation between *Aplodontia rufa columbiana* and *A. r. rufa* on the one hand and *A. r. rainieri* on the other. Specimens in the United States National Museum from the head of the Cascade River, Washington (nos. $\frac{30739}{42639}$, $\frac{30890}{42790}$, Biol. Surv. Coll.) are intermediate between *columbiana* and *rainieri*, although perhaps a trifle closer to the former. If, as seems likely, the distribution of *Aplodontia* is more or less continuous between Mount Rainier and the mountains in the Hope District, British Columbia, it is probable that one grades into the other by insensible degrees. Aside from its greater dimensions *columbiana* may be separated from *rufa* through its smaller-calibered, more pinched-up audital tubes, as compared with the larger, rounder tubes of *rufa*. *Columbiana* also has the zygomatic arch more expanded posteriorly than in *rufa*, as well as broader nasals posteriorly, and more closely approximated temporal ridges. From *rainieri* typical *columbiana* differs in having cranial measurements averaging greater, the difference being shown in length and width of nasals, length of incisive foramina, zygomatic width, mastoid width, and greatest length of mandible. The external auditory meatus tends to be of different shape in *columbiana*, being pinched up anteroposteriorly, while in *rainieri* the meatus is rounder and tends to be flattened dorsoventrally.

Aplodontia rufa rainieri Merriam

Mount Rainier Aplodontia

Aplodontia major rainieri Merriam (1899*a*), p. 21.
Haplodontia rufa rainieri, Elliot (1901), p. 112.
A[*plodontia*]. *r*[*ufa*]. *rainieri*, Trouessart (1904), p. 348.

Type.—Male adult, skull and skin; no. 90144, U. S. Nat. Mus., Biol. Surv. Coll.; Paradise Creek, south side of Mt. Rainier, Washington, alt. 5200 ft.; Aug. 6, 1897; collected by Vernon Bailey; orig. no. 6122.

Specimens Examined.—Total number 9, all from Washington; Pierce County—Mt. Rainier, Paradise Creek, 9 (1 skull only).

Geographic Range.—Known only from vicinity of type locality.

Cranial Characters.—Skull large (see measurements below); nasals long and comparatively straight sided; posterior two-thirds of outline tending to be slightly convex laterally, but usually with a slight lateral embayment far back; rostrum broad, as in *columbiana;* zygomatic arches moderate, proportionally lighter in weight, not so much expanded near posterior root as in *columbiana*, flat beneath in vicinity of posterior root; temporal ridges tending to remain separated for their entire length by several millimeters; caliber of audital tubes small; external auditory meatus round or flattened dorsoventrally.

External Characters.—Above, in summer skins, light ochraceous-buff, grizzled with blackish, the black hairs often with silvery white tips; a tendency observable toward concentration of blackish on middle line of back; sides having comparatively few black hairs; underparts deep quaker drab to light quaker drab, marked with whitish generally, such markings more conspicuous anteriorly on the throat; spot marks near light brownish drab; a sparse insprinkling of blackish hairs; a faint wash of pinkish buff in some examples.

Age Variation.—There is not so striking an actual decrease in width of interorbital constriction with age as is usual in the genus.

The youngest specimens all have this measurement broad. In some of the older ones it is broad, in others narrow. The zygomata are usually squarer and more expanded in the adults than in the young. The mastoid process is exceeded by the audital tube in all the adults, being, however, only slightly exceeded in the oldest ones, while in young specimens the audital tube materially exceeds the mastoid process. The width of the palate between the third premolar and the incisive foramina remains about the same, or even increases slightly, with age. Looking at the crania in side view, the ventral outline of the rostrum is nearly plane in the young, with slight eminences observable at the posterior end of the incisive foramina. In the adults the outline tends to be more rounded, the slight eminences having disappeared.

Molt.—Specimens collected on Mount Rainier on August 6 and 7 are with one exception (no. 90143, ♀, U. S. Nat. Mus., Biol. Surv. Coll.) beginning to molt. In one example (no. 90145, ♀, U. S. Nat. Mus., Biol. Surv. Coll.) hair renewal is taking place on small areas on the sides; in another (no. 90144, ♂) new hair is coming in on the right side only on an area one inch wide and four inches long, as well as in an irregular area on the top of the head; still another (no. 90137, ♂) is molting extensively laterally as well as in a small area on the head. The condition of this specimen suggests that the molt begins on the sides, and sometimes becomes quite extensive before the head molt starts at all.

Cranial Measurements of Type and Topotypes of *Aplodontia rufa rainieri*

(4 Skulls)

	Average	Mean	Maximum	Minimum
Basilar length	62.1	63.6	65.4	61.9
Length of nasals (3 skulls)	27.4	27.4	27.7	27.1
Width of nasals	12.4	12.7	14.0	11.4
Length of audital tube (2 skulls)	19.1	19.1	19.9	18.4
Length of incisive foramen	7.7	7.7	8.2	7.2
Zygomatic width	59.5	58.6	62.0	55.3
Greatest width of interpterygoid fossa	5.6	5.6	5.9	5.4
Mastoid width of cranium	55.6	55.6	57.8	53.5
Alveolar length superior cheek teeth	20.0	19.9	21.0	18.9
Distance between infraorbital foramina	17.1	17.1	18.1	16.2
Mandible, transversely across angular process	25.7	26.0	28.2	23.9
Mandible, greatest length	50.8	50.8	52.9	48.8

External Measurements of Type and Topotypes of *Aplodontia rufa rainieri*

(4 Skins)

	Average	Mean	Maximum	Minimum
Total length	377	379	384	365
Hind foot	62	63	65	62

Remarks.—Comparisons of examples of *Aplodontia rufa rainieri* from the type locality and *A. r. columbiana* from the head of the Cascade River, Washington, with specimens of *A. r. rufa* from the Puget Sound district (Kirkland, Seattle, Chilliwack, Sumas), and then with examples from localities more or less intermediate geographically and altitudinally, as Sauk and Easton, Washington, demonstrate beyond a doubt that intergradation takes place between *A. r. rufa* and the *rainieri-columbiana* series. A gradual change is indicated from the lowland *rufa* type to the mountain *rainieri-columbiana* type in size, in general cranial characters, and, particularly, in the dimensions and outline of the nasal bones and the size and outline of the external auditory meatus. More abundant material would doubtless supply more complete evidence for intergradation.

A. r. rainieri tends to be grayer than *A. r. rufa,* decidedly grayer than in the typical form, and to have less brown beneath. The nasals in *rainieri* tend to be broader posteriorly, and the caliber of the audital tubes tends to be less.

Aplodontia rufa pacifica Merriam

Pacific Aplodontia

Aplodontia pacifica Merriam (1899*a*), p. 19.
Haplodontia pacifica, Elliot (1901), p. 114.

Type.—Female adult, skull and skin; no. 77372, U. S. Nat. Mus., Biol. Surv. Coll.; Newport, mouth of Yaquina Bay, Oregon; March 20, 1896; collected by B. J. Bretherton; orig. no. 2219.

Specimens Examined.—A total of 46, from the following localities:

Oregon: Clatsop County—Astoria, 2; Mishawaka, 1 (skin only). Tillamook County—Wilson River, McNamer's Camp, 1. Lincoln County—Newport, 8. Lane County—Florence, 7; Mercer, 3; Eugene, 1; Spencer Butte, 4; Seaton, 3; Mapleton, 3. Douglas County—Smith River, 2; Gardiner, 4. Coos County—Coquille, 3 (1 skull only); "Coos County," 1. Curry County—Agness, 1; Port Orford, 1 (skull only). Josephine County—Briggs Creek (alt. 3000 ft.), 13 miles southwest of Galice, 1.

Geographic Range.—Coast of Oregon, from Astoria on the north at least to Port Orford on the south; ranging inland locally, as in the vicinity of Eugene, Oregon, and gradually intergrading with *Aplodontia rufa rufa,* probably in a broad belt centrally on the Pacific slope of Oregon from the northern to the southern boundaries of the state.

Cranial Characters.—Skull comparatively small (see measurements beyond); nasals broad anteriorly, becoming only a little narrower posteriorly, fairly uniform in outline through the series, comparatively straight laterally, with little or no anterior dilation; temporal lines or ridges not strongly marked, never approximated, though sometimes approaching to within a few millimeters of one another anteriorly; zygomatic arches comparatively light in weight, with weakly developed postorbital processes in certain specimens; fossae in front of lambdoidal ridge shallow; audital tubes of small caliber, notch dorsally in tubes short and broad; averaging smaller, on the basis of specimens measured, than *Aplodontia rufa rufa, A. r. olympica,* or *A. r. humboldtiana* in basilar length, width of nasals, length of audital tube, zygomatic width, mastoid width, alveolar length superior cheek teeth, distance between infraorbital foramina, and greatest length of mandible.

External Characters.—Above, in winter specimens, sayal brown or cinnamon to pinkish cinnamon, in one specimen (no. 9077, Field Mus. Nat. Hist.) approximating pinkish buff; many glossy black hairs interspersed, especially on back; top of head usually conspicuously black; in most specimens a black area or ill-defined broad band starting at nose and continuing back over head and posteriorly along middle of back to posterior end of body, this indefinite band grading into the browner coloration of the sides; face grayish in most examples; underparts grayish, with a more or less distinct brown wash varying from cinnamon or pinkish cinnamon to warm buff or pinkish buff.

Cranial Measurements of *Aplodontia rufa pacifica* (23 Skulls)

	Average	Mean	Maximum	Minimum
Basilar length	57.0	57.5	62.1	52.9
Length of nasals (19 skulls)	24.8	23.9	26.5	21.4
Width of nasals	10.4	10.5	11.4	9.6
Length of audital tube (15 skulls)	16.8	16.8	17.9	15.7
Length of incisive foramen	6.6	6.6	7.7	5.5
Zygomatic width	51.5	51.6	56.1	47.1
Greatest width of interpterygoid fossa	4.6	4.4	5.3	3.5
Mastoid width of cranium (22 skulls)	49.1	50.0	52.9	47.2
Alveolar length superior cheek teeth	18.6	18.6	20.3	16.9
Distance between infraorbital foramina	16.0	15.8	17.5	14.1
Mandible, transversely across angular process	22.5	23.1	25.3	20.9
Greatest length of mandible (22 skulls)	45.7	45.6	49.4	41.9

External Measurements of *Aplodontia rufa pacifica* (23 Skins)

	Average	Mean	Maximum	Minimum
Total length	316	324	356	293
Hind foot	51	52	57	48

Molt.—The molting process is just beginning in specimens of this subspecies taken June 19, June 29, July 17, and September 12. The example taken on the date last named is exceptional in molting so late. The end of the molt is shown by specimens secured on October 6 and October 24. Others taken October 5, 9, and 24 have completely assumed the new pelage.

Remarks.—*Aplodontia rufa pacifica* is usually separable from *A. r. olympica* by both external and cranial characters. Cranially the absence in *pacifica* of the postorbital process on the jugal in most cases serves to distinguish it from *olympica.* The nasals tend to be narrower as well as shorter in *pacifica,* and to be straighter sided. The skull is usually smaller in *pacifica,* and the temporal lines are more accentuated. *Pacifica* is grayer headed than is *olympica,* and there is in *pacifica* a concentration of blackish on the middle line of the back which is not so apparent in *olympica.* There is more brownish dorsally in *pacifica.* Ventrally *pacifica* has a conspicuous brown wash, while in *olympica* the ventral brownness is less noticeable.

From *Aplodontia rufa rufa, A. r. pacifica* may usually be separated through having a greater concentration of blackish dorsally. A uniform brownish tone dorsally is never observed in typical *pacifica,* but in *rufa* it is often observed. In specimens which are not so distinctly brownish *pacifica* tends to be blackish while *rufa* tends to be grayish. Color fails completely to allocate certain specimens from intermediate localities. Thus examples from Siskiyou, Oregon, are in coloration *pacifica,* while in size and certain skull characters they are closer to *rufa.* Others from the vicinity of Eugene and other localities in Lane County, Oregon, have the coloration of *rufa* but certain other characters of *pacifica.* Cranially *pacifica* is usually separable from *rufa* through possession of nasals narrower anteriorly and proportionally broader posteriorly, lighter zygomatic arches, smaller average measurements throughout, audital tubes shorter and of lesser caliber, and shallower fossae anterior of the lambdoidal crests.

Smaller size and different coloration separate *Aplodontia rufa pacifica* from *A. r. humboldtiana.* From *A. r. pacifica* one gets the impression of rich brown with black hairs plentifully insprinkled and specially emphasized on the middle line of the back, while from *humboldtiana* one receives the impression of black sparsely interspersed with buffy. Cranially *pacifica,* while very close to *humboldtiana,* can usually be separated therefrom through the possession of nasals with straighter lateral outline.

Specimens of *Aplodontia rufa pacifica* from Mercer, Lane County, Oregon, tend to be uniformly larger than others from the coastal region. One of them (no. 1600, Univ. Ore. Mus.) gives the maximum measurement in a series of more than twenty skulls in basilar length, length of nasals, zygomatic width, alveolar length superior cheek teeth, distance between infraorbital foramina, distance transversely across angular process of mandible, and greatest length of mandible.

All specimens of aplodontia collected on or very close to the coast line (except the examples from Mercer just mentioned, and a skull only, from Port Orford, Oregon, no. 206368, U. S. Nat. Mus., Biol. Surv. Coll., which has broader nasals) are typical of the Newport form; but as specimens from points farther away from the coast are examined an increase in size is apparent, and the characters and coloration tend in the direction of *rufa*. To this category belong specimens from Lane County, referred to *pacifica* (as no. 204887, U. S. Nat. Mus., Biol. Surv. Coll.), examples from Siskiyou, Oregon, referred to *rufa* (see p. 460), and a specimen from Briggs Creek, Oregon, thirteen miles southwest of Galice (no. 205239, U. S. Nat. Mus., Biol. Surv. Coll.), referred to *pacifica*. Examples from these localities partake of the characteristics of two subspecies often in nearly the same degree, and some or all of them might be referred to one with almost as much propriety as to the other.

Intergradation with *rufa* is demonstrated by specimens of *pacifica* from Spencer Butte, seven miles south of Eugene, Oregon, and by examples of *rufa* from Siskiyou, Oregon. It seems probable that intergradation between the two forms takes place over a broad area north and south through central Oregon.

Aplodontia rufa humboldtiana Taylor

Humboldt Aplodontia

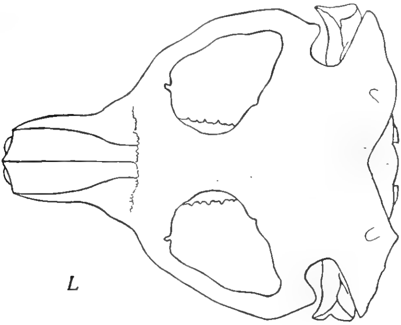
Aplodontia rufus (part), Price (1894), p. 328.
Haplodontia phaea (part), Elliot (1903), pp. 184, 185.
Aplodontia phaea (part), Stephens (1906), p. 95.
Aplodontia humboldtiana Taylor (1916*a*), pp. 21–23.

Type.—Male adult; no. 21162, Mus. Vert. Zool.; Carlotta, Humboldt County, California; January 4, 1914; collected by H. E. Wilder; orig. no. 1494; stuffed skin, with skull and jaws, all in good condition.

Specimens Examined.—A total of 24, from the following localities:

California: Del Norte County—Requa, 1. Humboldt County—Sam Lane's Ranch, 12 miles north of Hoopa, 3 miles southwest of Weitzpek, 3; Eureka, 5; Carlotta, 8; Cuddeback, 7.

Geographic Range.—The northern coast district of California from Humboldt Bay, Carlotta, and Cuddeback along the coast in Humboldt and Del Norte counties northward, at least to Requa; ranging inland locally in Humboldt County and intergrading with *A. r. rufa* in the vicinity of Weitzpek.



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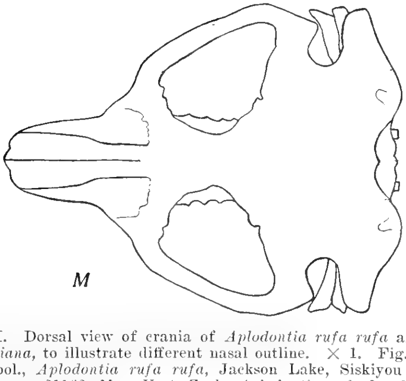


M

Figs. L, M. Dorsal view of crania of *Aplodontia rufa rufa* and *Aplodontia rufa humboldtiana*, to illustrate different nasal outline. × 1. Fig. L, no. 13326, Mus. Vert. Zool., *Aplodontia rufa rufa*, Jackson Lake, Siskiyou County, California; fig. M, no. 21162, Mus. Vert. Zool., *Aplodontia rufa humboldtiana*, Carlotta, Humboldt County, California.

Cranial Characters.—Skull moderate in size (see measurements below); nasal outline variable, but usually broad anteriorly, with a shallow embayment in lateral outline, not exceptionally compressed posteriorly (see text fig. M); zygomatic arches light to medium in weight, with position of postorbital processes on the jugal faintly indicated in six crania out of sixteen; temporal ridges comparatively well marked, more accentuated than in either *Aplodontia rufa rufa* or *A. r. pacifica,* in some skulls widely separated, as in *pacifica,* in others approaching to within a few millimeters of each other, as in *rufa;* audital tubes tending to be of smaller caliber than in *rufa,* larger and straighter than in *pacifica;* incisive foramina comparatively short.

External Characters.—Above, light ochraceous-buff or pinkish buff, obscured by an admixture of black hairs which is nearly uniform over all upper parts—an insprinkling of silvery-tipped hairs augments the grizzled appearance—some specimens appearing conspicuously blackish; under parts near pale quaker drab with many silvery white hairs; the faintest possible wash of buffy brown observable in certain examples; a white spot usually present posteriorly in the vicinity of the external genitalia.

Sexual Differences.—Three males out of eleven have total length greater than the maximum of that measurement in the females; six have tail vertebrae longer than this maximum, and six also have hind foot longer. Comparison of fall examples demonstrates that the three darkest specimens are males, their darker coloration being more evident ventrally. In this species in fall pelage the spot marks about the mammae do not afford a distinctive character. While they are in evidence in certain specimens of both sexes, they are lacking in others. In examples having the spot marks, females have them more accentuated than males.

There is a tendency for the ridges and processes in the skulls of males to be somewhat more accentuated than in those of females. Temporal lines or ridges appear to come closer together with old age in males than in females.

Molt.—Two young specimens (nos. 9061, 9062, Field Mus. Nat. Hist.), collected August 16 and August 18, respectively, are molting into the adult pelage. The adult coat has replaced the juvenal pelage everywhere in these specimens except in a narrow band across the shoulders, although a patchy appearance posteriorly in one of them (no. 9061) suggests that the molt is incomplete in that region. An adult specimen (no. 21159, ♂, Mus. Vert. Zool.) taken at Carlotta, Humboldt County, November 5, has almost completely assumed the fresh pelage. New hair is still coming in on a narrow longitudinal line on the back posteriorly. Another specimen (no. 21156, ♂, Mus. Vert. Zool.) taken October 29 has the winter pelage complete.

CRANIAL MEASUREMENTS OF *Aplodontia humboldtiana* (15 SKULLS)

	Average	Mean	Maximum	Minimum
Basilar length	58.8	58.7	62.5	55.0
Length of nasals (11 skulls)	24.5	23.8	26.0	21.9
Width of nasals	11.2	11.2	12.4	10.0
Length of audital tube (12 skulls)	18.4	18.0	19.5	16.5
Length of incisive foramen	5.9	6.5	8.2	4.8
Zygomatic width	53.8	53.2	57.9	48.6
Greatest width of interpterygoid fossa	5.5	5.7	6.7	4.8
Mastoid width of cranium	52.3	51.7	57.4	46.0
Alveolar length superior cheek teeth	18.8	18.6	19.7	17.6
Distance between infraorbital foramina	16.4	17.1	18.9	15.4
Mandible, transversely across angular process	22.2	21.6	23.9	19.4
Mandible, greatest length	48.1	48.1	50.7	45.6

EXTERNAL MEASUREMENTS OF *Aplodontia humboldtiana* (15 SKINS)

	Average	Mean	Maximum	Minimum
Total length	346	333	367	300
Hind foot	56	56	63	50

Remarks.—*Aplodontia rufa humboldtiana* is larger and less richly colored than *Aplodontia rufa pacifica* of the coast region of Oregon (see p. 469). *Humboldtiana* is similar in coloration to *A. r. rufa*, of the Trinity-Siskiyou Mountain region to the eastward, but darker, a paler hue of the brown series of colors being interspersed with the black hairs. The Humboldt aplodontia is not so black as is *A. r. nigra*, its nearest neighbor on the south, although in certain cranial characters, notably width of nasals, length of incisive foramen, zygomatic width, greatest width of interpterygoid fossa, and mastoid width, it is closer to *nigra* than to any other one of its neighbors.

Specimens from Sam Lane's Ranch, twelve miles north of Hoopa and three miles southwest of Weitzpek, on the divide between the Klamath and Trinity rivers (nos. 97290, 97291, 98475, U. S. Nat. Mus., Biol. Surv. Coll.), here referred to *humboldtiana*, show intergradation in the direction of *A. r. rufa*.

Aplodontia rufa californica (Peters)

Sierra Aplodontia

Aplodontia leporina (part), Audubon and Bachman (1854), pp. 99–103.
Marmot, Mammoth Mole, Calif. Acad. Nat. Sci. (1855), p. 71.
H[aplodon]. leporinus var. *Californicus* Peters (1865), pp. 177–179.
H[aploodon]. californicus, Lilljeborg (1866), p. 41.
Haplodon rufus, Coues (1877*b*), p. 557.
Aplodontia major Merriam (1886), p. 316.
H[aplodon]. major, Townsend (1887), p. 174, footnote.
H[aplodontia]. major, Elliot (1899), p. 251.
Haplodontia rufa californica, Elliot (1901), p. 112.
Aplodontia rufa californica, Trouessart (1904), p. 348.
Aplodontia californica, Grinnell (1913), p. 344.

Type.—A skin and skull in the Berlin Museum.

Type Locality.—Assumed to be the Sierra Nevada of California (Grinnell, 1913, p. 344); specimens from Blue Cañon in the central Sierra may be regarded as typical.

The tenability of Peters' name for this subspecies depends on answers to two questions: first, was Peters' specimen an *Aplodontia* at all, and, second, if an *Aplodontia,* what was its source? Answering the first, it seems clear from Peters' description, which is fairly detailed, which takes account of both skull and skin, and which was evidently drawn up with Baird's figure of the skull of *Aplodontia leporina* at hand, that the mammal discussed is an aplodontia. The fact that Peters fell into error in a portion of his description does not appear to alter the case from the nomenclatural standpoint. *Aplodontia* is the only known mammal occurring in California or North America which possesses approximately the characters set down by Peters. His references to the inflected angle of the jaw of the animal he had in hand and to its short tail alone suffice to demonstrate its position.

The following considerations seem germane to a discussion of the second question: The discovery of gold in the Sierra Nevada of California in 1848 brought great numbers of people to this section from all parts of the world. It is well known that aplodontias occur in the Sierra not far from the center of early mining activity, and it is highly probable that some early naturalist collected here the specimen which later became the basis of Peters' new form.[1]

The type of "*H[aplodon]. leporinus* var. *Californicus*" is stated to have come "aus den Gebirgen Californiens." From early times the Sierra Nevada have impressed travelers and map makers as the most noteworthy mountains within the state. The only other mountains within its boundaries in which aplodontias occur are the Trinity-Siskiyou ranges of northern California. The chance that Peters' specimen came from these then little known mountains rather than from the Sierra Nevada is slight.

Absolute finality of decision as to the name of the Sierra aplodontia is impossible without access to Peters' specimen. In deference

[1] Soon after the discovery of gold California became comparatively well known, even in Europe. Phillips (*List of Maps of America in the Library of Congress,* 1901, pp. 183–186) lists no less than four maps published in Europe between 1848 and 1865 (the date of Peters' publication of the name *californica*), according to which the boundaries of the state are approximately correct. The maps are those of Duflot de Mofras, Paris, 1849; Desfontaines, Paris, 1849; Reimer, Berlin, 1856; and Rossi, Paris, 1863.

to the above considerations, however, the writer finds himself unable to agree with Dr. C. Hart Merriam in regarding Peters' name as untenable, but is forced to consider that the balance of the evidence now available favors its validity.

Specimens Examined.—A total of 75, from localities as follows:

California: Siskiyou County—Mt. Shasta, Upper Ash Creek (alt. 7000 ft.), 2; Mt. Shasta, Upper Mud Creek (alt. 7000 ft.), 8. Lassen County—Lassen Peak, upper edge Canadian zone, east side, 1; Susanville, mountains 12 miles west, 1. Sierra County—Salmon Lake (alt. 6600 ft.), 5. Placer County—Blue Cañon, 21. El Dorado County—Lake Tahoe, Emerald Bay, 3; South Fork of American River, 1. Alpine County—Hope Valley, 10. Mariposa County—Yosemite Park, East Fork Indian Cañon, 2; near Porcupine Flat, 1; head of Lyell Cañon (alt. 9700 ft.), 5; Mt. Lyell, 4; Chinquapin (alt. 6256 ft.), 5. Mono County—Mammoth, 4 (2 skulls only).

Geographic Range.—The Sierra Nevada of California, from Mt. Shasta on the north at least to Mammoth, Mono County, on the south. Zonal range, Boreal.

Cranial Characters.—Skull large (see measurements below), similar, in dimensions, to *Aplodontia rufa rainieri* and *A. r. columbiana*, averaging slightly larger than *A. r. rufa;* rostrum comparatively long, zygomatic arches heavy, tending to be squarer anteriorly than in any other aplodontia; zygomatic arches usually not so much expanded at the posterior root, viewing cranium on its dorsal or ventral aspect, as in *columbiana;* distinct fossa present in typical material on under surface of expanded portion near posterior root, unlike most examples of *rainieri* and *columbiana* in this respect; postorbital processes on the jugal sometimes faintly indicated; temporal ridges tending to approach to within a few millimeters of each other for their entire length, variously accentuated in different specimens; caliber of audital tubes variable, but averaging decidedly greater than in either typical *rainieri* or in *columbiana*, about the same as in *rufa;* external auditory meatus round or slightly flattened dorsoventrally, as in *rainieri*.

External Characters.—Above, in summer skins, pale ochraceous-buff to ochraceous-buff, in most specimens uniformly grizzled with blackish, and with an insprinkling of silvery tipped hairs; amount and concentration of black varying to a considerable extent; white spot at base of ear (pl. 29); underparts light mouse gray to quaker drab, with insprinkling of black hairs, often silvery tipped, certain specimens with indistinct wash of brown coloration near pinkish buff or light buff, others with a suggestion of light ochraceous-buff. Coloration of winter specimens only slightly different from that in summer.

While the coloration of adults and young is similar, the latter are woollier and grayer in general appearance than in the former.

Age Variation.—Cranially there is a tendency for the sutures between the nasals posteriorly, the premaxillaries and the frontals to remain open longer than is the case in other species. The interorbital constriction undergoes a proportional and with some exceptions an actual decrease with age. The zygomata are heavier in adults than in the young and tend to be more bowed outward, or squarer, anteriorly. Temporal lines or ridges come closer together with age. In some old adults of this species they almost coalesce anteriorly, while remaining only four or five millimeters apart posteriorly. Although the mastoid process tends to grow laterad more rapidly than the audital tube with age, in almost all the available specimens the latter exceeds the former in length.

Sexual Differences.—The crania of males tend to be larger than those of females in nearly all measurements; zygomata are heavier in males; and the temporal lines or ridges tend to be more accentuated and more closely approximated. The females tend to have interpterygoid fossa proportionally broader than the males. In seven out of eleven males measured the mandible, transversely across angular process, is greater than the maximum for the females. Examination of the material before me confirms C. Hart Merriam's (1886, pp. 327, 328) conclusions regarding cranial differences due to sex in this species except in certain details respecting the suture which separates the frontal bones from the premaxillaries and nasals, and in the outline of the postzygomatic notches. In Merriam's material the suture in question is open in the females and closed in males, while in the material before me there is nearly as strong a tendency toward effacement of the suture in females as in males. In Merriam's material the postzygomatic notches are larger in females, while in the material now available no constant sexual differences in this respect can be made out. Our specimens like those examined by Merriam have the skulls of the females less heavy and massive than those of the males, the occipital crest not so highly developed, and the zygomatic arches not so much bowed outward.

Molt and Seasonal Change.—As in other subspecies of *rufa,* molting takes place during late summer and early fall. The earliest molting specimen examined is a female taken July 21. Most examples taken during August and September are well along in the molting process, while those secured in October show its last stages, and a specimen taken on October 15 (no. 192618, ♂, U. S. Nat. Mus., Merriam Coll.) has the winter pelage complete. An example taken on August 27 (no. 110241, ♂ ad., U. S. Nat. Mus., Biol. Surv. Coll.) shows no sign of molt, to all appearances having assumed the fresh pelage. One taken August 29 (no. 110243, ♀ ad., U. S. Nat. Mus., Biol. Surv. Coll.) has the new pelage nearly complete. A few scattered hairs are still coming in on the sides posteriorly and far back ventrally. These two specimens have completed the molt at an exceptionally early date. In one specimen (no. 67854, ♀, September 8, U. S. Nat. Mus., Biol. Surv. Coll.) the pelage has been renewed dorsally on the anterior three-fourths of the body. In another (no. 192617, ♂, October 12, U. S. Nat. Mus., Merriam Coll.) all the pelage dorsally has been renewed except in a band about two inches wide across the body just back of the shoulders.

Young specimens do not conform exactly to the schedule of the adults. In one example (no. 22617, Mus. Vert. Zool.) taken June 19 the new pelage covers the head and extends posteriorly to a line transversely across the body from one to two inches back of the ear; it appears in a small spot just back of the nape of the neck; and it is more conspicuous than elsewhere in a broad band about four inches wide, extending from side to side across the body in the middle of the back. Often a vigorous hair renewal becomes apparent only upon a close examination. A juvenal (no. 192615, ♂, October 9, U. S. Nat. Mus., Merriam Coll.) in which the hair is being renewed on hips, head, and neck exemplifies this state of affairs. In a third juvenal (no. 110247, August 30, U. S. Nat. Mus., Biol. Surv. Coll.) new hair is coming in on areas two inches wide and three inches long far back on the sides.

The fresh pelage is longer and a trifle browner than the worn pelage it replaces. Wear has a tendency to expose the darker under portions of the pelage, so that the summer pelage appears a little darker than the fresh fall pelage. The differences between the pelages are slight at most, and often none are observable.

Remarks.—*Aplodontia rufa californica* differs from *A. r. rufa* of the Trinity-Siskiyou region of southern Oregon and northern California in having more grayish coloration and in cranial characters as follows: Nasal outline uniform in *californica*, moderately broad in front, moderately narrow posteriorly (nasals in *rufa* variable, usually proportionally broader anteriorly and narrower posteriorly); widest portion of nasals usually most anterior point where nasals touch maxillaries (often posterior of this point in *rufa*); shallow embayment in lateral outline of nasals posteriorly (variable in *rufa*); rostrum and nasals longer in *californica*, zygomatic arches squarer anteriorly, caliber of audital tubes averaging greater (about equal to caliber in typical *rufa*). From *A. r. rainieri*, *californica* differs in the following skull characters: nasals tending to be broadest at a more anterior point; a more pronounced tendency observable toward approximation of temporal ridges; heavier zygomatic arches, squarer anteriorly; and great caliber of audital tubes.

Cranial Measurements of *Aplodontia rufa californica* (14 Skulls)

	Average	Mean	Maximum	Minimum
Basilar length	61.1	62.4	65.1	59.6
Length of nasals (8 skulls)	26.8	26.9	28.4	25.4
Width of nasals	12.1	12.0	12.8	11.2
Length of audital tube (12 skulls)	19.1	18.9	20.5	17.2
Length of incisive foramen	7.6	7.6	8.2	7.1
Zygomatic width	57.6	57.0	60.9	53.1
Greatest width of interpterygoid fossa	5.2	5.2	5.8	4.7
Mastoid width of cranium	54.2	53.9	57.0	50.7
Alveolar length of superior cheek teeth	19.6	19.6	20.7	17.5
Distance between infraorbital foramina	17.6	17.4	18.4	16.4
Mandible, transversely across angular process	24.5	24.4	26.6	22.1
Mandible, greatest length	50.5	49.9	53.2	46.7

External Measurements of *Aplodontia rufa californica* (17 Skins)

	Average	Mean	Maximum	Minimum
Total length	352	352	380	325
Hind foot	60	59	64	55

Cranial measurements of three males from Blue Cañon, California: basilar length, 64.3, 63.1, 62.8; length of nasals, 29.1, 27.0, 27.0; width of nasals, 12.6, 13.0, 12.8; zygomatic width, 61.9, 61.4, 61.2; mastoid width, 59.4, 59.9, 57.9. Cranial measurements of three females from the same locality: basilar length, 60.7, 61.9, 60.5; length of nasals, 27.6, 27.2, 27.0; width of nasals, 12.0, 11.9, 12.2; zygomatic width, 55.5, 60.9, 57.8; mastoid width, 53.4, 57.9, 54.8.

Californica is one of the more consistent subspecies of *Aplodontia rufa*, maintaining its characters with considerable uniformity throughout its range. Still, a series of specimens from Mount Shasta, California, while indistinguishable cranially from typical *californica*, is characterized by slightly darker coloration dorsally.

Squareness anteriorly of the zygomatic arches and outline of the nasals in specimens of *rufa* from Mount Mazama in southern Oregon suggest intergradation with *californica*, as do also certain cranial characteristics of examples from Cañon Creek, California. The latter exemplify a tendency to combine the square zygomatic arches and the distinctive nasal outline of *californica* with the short rostrum and browner coloration of *rufa*.

Aplodontia rufa nigra Taylor

Point Arena Aplodontia

Aplodontia nigra Taylor (1914), pp. 297–300.

Type.—Male adult; no. 20320, Mus. Vert. Zool.; Point Arena, Mendocino County, California; July 10, 1913; collected by C. L. Camp; orig. no. 1003.

Specimens Examined.—Total number 4, all from California: Mendocino County—Point Arena.

Geographic Range.—Known only from the type locality, where it is found within an area of approximately twenty-four square miles.

Cranial Characters.—Skull moderate in size (see measurements below); nasals dilated anteriorly, comparatively contracted posteriorly; zygomatic arch medium in weight, squarish anteriorly; position of postorbital process faintly indicated; temporal lines or ridges not closely approaching; incisive foramina short; notch dorsally on external auditory meatus deeper than in *Aplodontia rufa humboldtiana*, more as in *A. r. pacifica*.

External Characters.—Summer specimens, above shiny black, with a sparse insprinkling of pinkish buff hairs and with plumbeous bases of the hairs showing through to a certain extent, the whole giving the impression of shiny black faintly sprinkled with grayish; sides paler than back, prevailingly pinkish buff, with heavy insprinkling of black hairs; head tending to be shiny black; face dark quaker drab; underparts cinereous to plumbeous, lightly washed with pinkish buff.

Age Variation.—This subspecies exhibits a remarkable similarity in the characters of adult and young. The coal black dorsal coloration, as well as the anterior dilation of the nasal outline, are conspicuous in both. In one young example (no. 20321, Mus. Vert. Zool.) a single small bony element is marked off by sutures in the interparietal region. The zygomata are decidedly heavier in the adult than in the young, as well as somewhat more expanded anteriorly.

Molt.—Three young at hand (nos. 20318, 20319, and 20321, Mus. Vert. Zool., taken July 9 to 11) are molting from the juvenal pelage into that of the adult. The new pelage is more intensely brown and black than the gray-black pelage of the juvenal, the brown being more emphasized laterally, the black dorsally.

Remarks.—*Aplodontia rufa nigra* is the most strikingly marked subspecies of mountain beaver known, its dorsal coloration rendering it the darkest form as yet characterized. Both old and young may be separated with certainty on coloration alone from any known form of the genus. The anterior dilation of its nasal outline serves to separate it from *A. r. phaea* and *A. r. pacifica.* From *A. r. humboldtiana,* its nearest neighbor on the north, it is separated by its darker coloration and, in general, smaller size.

Cranial Measurements of *Aplodontia rufa nigra* (1 Cranium)

Basilar length	57.1
Length of nasals	23.2
Width of nasals	11.0
Length of audital tube	17.3
Length of incisive foramen	6.0
Zygomatic width	53.7
Greatest width of interpterygoid fossa	5.6
Mastoid width of cranium	51.8
Alveolar length superior cheek teeth	18.4
Distance between infraorbital foramina	15.3
Mandible, transversely across angular process	22.7
Mandible, greatest length	45.1

External Measurements of *Aplodontia rufa nigra* (1 Skin)

Total length	346
Hind foot	55

That *Aplodontia rufa nigra* finds in *A. r. humboldtiana* and in *A. r. phaea* its nearest relatives seems reasonably clear. The blackish coloration of the Point Arena form suggests the dark coloration of the Humboldt Bay race, while its size and the length of incisive foramina of the skull show that it is not far from *phaea.*

The distinctive coloration of all the known specimens of *A. r. nigra* and its geographical isolation constitute, perhaps, arguments for its recognition as a full species. On the other hand, the paucity of material representative of the form, coupled with the amplitude of individual variation in other forms in the genus, and with the evident overlapping of cranial characters with *humboldtiana* on the one side and *phaea* on the other, indicate the propriety, for the present at least, of allocating *nigra* as a subspecies of *rufa.*

Aplodontia rufa phaea Merriam

Point Reyes Aplodontia

?*Haplodon rufus,* True (1885), p. 596.
Aplodontia phaea Merriam (1899*a*), p. 20.
Haplodontia phaea, Elliot (1901), p. 114.

Type.—Male adult, skin and skull; no. 186475, U. S. Nat. Mus., Merriam Coll. (no. $\frac{2645}{3273}$); Point Reyes, Marin County, California; August 1, 1886; collected by C. A. Allen; orig. no. 142.

Specimens Examined.—A total of 36, from the following localities:

California: Marin County—Five miles west of Inverness, 9; six miles west of Inverness, 7; four miles south of Olema, 3; Lagunitas, 2; Point Reyes, 15 (1, skull only; 3, jaws only, labeled under one number).

Geographic Range.—Favorable situations in Marin County, California, where it is found within an area of approximately 110 square miles.

Cranial Characters.—Skull small (see measurements below); nasals not extreme, nearly straight sided, narrow across posterior ends, not extremely wide at anterior ends; zygomatic arch light, not conspicuously squarish anteriorly; temporal lines or ridges not unduly accentuated, wide apart; audital tube comparatively large calibered; fossae anterior of lambdoidal crests shallow; notch dorsally on external auditory meatus shallow; incisive foramina short; interpterygoid fossa narrow.

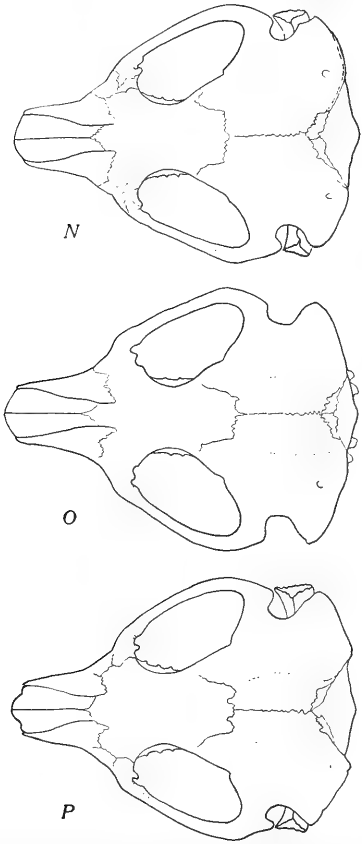
External Characters.—Above, in summer skins, pinkish cinnamon to cinnamon-buff, in winter approximating cinnamon or even tending toward sayal brown, sometimes grayish; all upperparts uniformly grizzled with black-tipped hairs, which are somewhat more numerous on the back than on the sides. Underparts French gray to plumbeous, with a sparse insprinkling of black hairs; the whole ventral surface washed with light ochraceous-buff to pinkish buff. Two specimens (nos. 192629, 192631, U. S. Nat. Mus., Merriam Coll.) have small white spots on the throat. One example (no. 192635, U. S. Nat. Mus., Merriam Coll.) is melanistic, being light seal brown in color above and below.

Age Variation.—Illustrative of the decrease in width of the interorbital constriction with age are the measurements obtained from ten specimens of this species, in which the ratio of the width of interorbital constriction to basilar length varies from 26.2 per cent in a very young example to only 17.1 per cent in an adult.

In several of the youngest specimens there are two small bones marked off by sutures in the interparietal region. They soon disappear through ankylosis.

In ventral view it may be noted that with age the part of the palate between the third premolar and the incisive foramina becomes narrower. One striking feature noticed here is that while the basilar length varies with age in certain specimens examined from 42.9 mm. to 55.5 mm., the width of the palate between right and left premolar four remains constant at about 5 millimeters.

The ratio of the width of the angular portion of the jaw to the length of the jaw undergoes, in specimens measured, a 5 per cent increase with age. In youth there is a smooth space between the inner prominence of the angle and the ridge in front of the masseteric fossa, while in old age there is a tendency for this ridge to be continued



Figs. N–P. Dorsal view of crania of young specimens of *Aplodontia rufa phaea*, to illustrate marking off of interparietal elements. × 1. Fig. N, no. 20302, Mus. Vert. Zool.; fig. O, no. 20308, Mus. Vert. Zool.; fig. P, no. 20316, Mus. Vert. Zool.

across the lower side of the ramus and connected with the inner prominence of the angle.

Seasonal Change.—Molt begins the last of July or the first of August. Specimens taken September 17 and November 9 have the process about completed, and one secured November 12 has entirely finished molting. More black hairs are sprinkled into the winter pelage, and the hair is somewhat longer and thicker. The spot marks about the mammae in the females are much less conspicuous in winter than in summer.

CRANIAL MEASUREMENTS OF *Aplodontia rufa phaea* (11 SKULLS)

	Average	Mean	Maximum	Minimum
Basilar length	55.6	54.8	58.6	51.1
Length of nasals (4 skulls)	21.5	22.0	23.7	20.3
Width of nasals	9.6	9.5	10.3	8.7
Length of audital tube (9 skulls)	16.3	16.4	17.2	15.6
Length of incisive foramen	6.2	6.1	7.6	4.5
Zygomatic width	50.3	49.5	53.0	46.0
Greatest width of interpterygoid fossa	4.3	4.2	4.7	3.8
Mastoid width of cranium	47.2	46.4	51.0	41.9
Alveolar length superior cheek teeth	18.4	18.5	19.2	17.9
Distance between infraorbital foramina	15.1	15.3	16.5	14.1
Mandible, transversely across angular process	21.6	21.7	22.8	20.7
Mandible, greatest length	43.1	43.4	45.1	41.7

EXTERNAL MEASUREMENTS OF *Aplodontia rufa phaea* (13 SKINS)

	Average	Mean	Maximum	Minimum
Total length	308	312	344	280
Hind foot	52	52	57	48

Remarks.—*Aplodontia rufa phaea* is the smallest subspecies in the genus. It is also the palest of the coastal forms of *Aplodontia* (*pacifica, humboldtiana, nigra, phaea*) occurring in Oregon and California. Cranially its closest affinities seem to be with *Aplodontia rufa nigra.*

In spite of the geographical isolation of the Marin County form, it is very similar, in general coloration, to some examples of *rufa;* nor are its cranial characters sufficiently distinctive to warrant its recognition as of more than subspecific rank.

F. LITERATURE CITED, WITH TITLES OF OTHER WORKS CONTAINING MATTER ON *APLODONTIA*

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Two species of *Aplodontia*—*A. californica* and *A. phaea*—listed as occurring in California (p. 344).

1915. The vertebrate fauna of the Pacific Coast, *in* Nature and science on the Pacific Coast. (San Francisco, Elder), pp. 104–114, pls. 12–14.

Aplodontia mentioned (p. 110); photograph of live animal (pl. 14, opp. p. 118).

1916. An analysis of the vertebrate fauna of the Trinity region of northern California. Univ. Calif. Publ. Zool., **12**, 399–410.

In course of analysis mentions *A*[*plodontia*]. *californica* (p. 401), and *Aplodontia chryseola* (pp. 401, 402, 407).

HARLAN, R.

1825. Fauna Americana. (Philadelphia, Finley), pp. i–x, 11–318.

Compilation of matter on *Arctomys rufa* (addenda, pp. 308–309).

HOLDER, J. B.

1877. History of the American Fauna, in the Museum of Natural History. (New York, Virtue), pp. i–ccxc, 11 pls.

Short compilation; treats family Haplodontidae, genus *Haplodon* and the species *Haplodon rufus* (p. xc).

KELLOGG, L.

1910. Rodent fauna of the late Tertiary beds at Virgin Valley and Thousand Creek, Nevada. Univ. Calif. Publ. Bull. Dept. Geol., **5**, 421–437, 20 figs. in text.

Aplodontia alexandrae briefly discussed (p. 429).

1912. Pleistocene rodents of California. Univ. Calif. Publ. Bull. Dept. Geol., **7**, 151–168, 16 figs. in text.

Discussion of *Aplodontia major fossilis* from Samwel and Potter Creek caves in California (pp. 157–158); incidental mention of *Aplodontia major* (p. 158).

1914. *Aplodontia chryseola*, a new mountain beaver from the Trinity region of northern California. Univ. Calif. Publ. Zool., **12**, 295–296.

Original description of *Aplodontia chryseola.*

1916. Report upon mammals and birds found in portions of Trinity, Siskiyou and Shasta counties, California. Univ. Calif. Publ. Zool., **12**, 335–398, pls. 15–18, 1 fig. in text.

Relationships, occurrence and habits of *Aplodontia chryseola* (pp. 369–372).

LANTZ, D. E.

1917. Destroying rodent pests on the farm. Yearbook, U. S. Dept. Agr., Separate **708** (1916), 1–18, 5 pls., 1 fig. in text.
Damage done by aplodontia to crops in western Washington mentioned (p. 16); half-tone of aplodontia (plate 1, fig. 1).

LESSON, R. P.

1827. Manuel de mammalogie ou histoire naturelle des mammifères(Paris, Roret), xv + 442 pp.
Short paragraph on *Anisonyx roux* (p. 240); evidently compiled from Rafinesque and Harlan.

LEWIS, M., and CLARK, W.

1814. History of the Lewis and Clark Expedition. (Paul Allen edition, Philadelphia, Bradford), **2**, ix + 522.
Description of "Sewellel" (pp. 176–177).

1876. An account of the various publications relating to the travels of Lewis and Clark, with a commentary on the zoological results of their Expedition; Elliott Coues, *in* U. S. Geol. and Geog. Surv. Terr. (2), Bull. **6**, 417–444.
Short compilation regarding the Sewellel (p. 437).

1893. History of the Expedition under the command of Lewis and Clark. 4 vols. (Coues edition, New York, Harper), **3**, i–vi, 821–1298.
Extract on the Sewellel from the journals of Lewis and Clark (pp. 861–862); critical remarks (footnote, p. 861).

1904–5. Original journals of the Lewis and Clark Expedition, 1804–1806. 8 vols. (Thwaites' edition, New York, Dodd), **8** [Atlas], i–xvi, 54 maps.
Parts 1 and 2 of map 32 are of particular interest as showing the localities on the Columbia River visited by Lewis and Clark.

LILLJEBORG, W.

1866. Systematisk öfversigt af de gnagande Däggdjuren, Glires. (Upsala, Kongl. Akad. Boktryckeriet), pp. 1–59.
Family Haploodontidae placed between Sciuridae and Chinchillidae in table, opp. p. 9; family discussed (p. 41).

LORD, J. K.

1866. The naturalist in Vancouver Island and British Columbia. 2 vols. (London, Bentley), **1**, xiv + 358, frontisp., 6 illus. in text.
Chapter 13 devoted to discussion of habits, Indian names, and distribution of *Aplodontia leporina*.

LUM, S. K.

1878. The sewellel or show'tl. Amer. Nat., **12**, January, 10–13.
Remarks on distribution and habits of *Haplodon rufus*.

[LYDEKKER, R.]

1914. Guide to the galleries of Mammals in the Department of Zoology of the British Museum (Natural History), (ed. 9, London, British Museum), 123 pp., 1 pl., 3 plans, 65 figs. in text.
Reference to Aplodontiidae and the genus *Aplodontia* (p. 57).

LYON, M. W., Jr.

1907. Notes on mammals collected at Mount Rainier, Washington. Smithsonian Misc. Coll., **50**, 89–92.
Aplodontia major rainieri discussed (p. 91).

Lyon, M. W., Jr., and Osgood, W. H.

1909. Catalogue of the type-specimens of mammals in the U. S. National Museum, including the Biological Survey collection. U. S. Nat. Mus., Bull. **62,** x + 325.

The types of three forms of *Aplodontia* were in the Biological Survey Collection on the date of publication of this catalogue, as follows: *Aplodontia olympica, A. pacifica,* and *A. major rainieri* (pp. 159–160).

Marsh, O. C.

1877. New vertebrate fossils. Amer. Jour. Sci. (3), **14,** 249–256.

Original description of the genus *Allomys* (p. 253).

Matteson, F. S.

1877. The mountain boomer, or showtl. Amer. Nat., **11,** 434–435.

Letter regarding habits of aplodontia.

Matthew, W. D., and Gidley, J. W.

1904. New or little known mammals from the Miocene of South Dakota. Amer. Mus. Exp. 1903. Bull. Amer. Mus. Nat. Hist., **20,** 241–268, 15 figs. in text.

Meniscomys sp. indt., recovered in Rosebud beds; comparison of *Meniscomys* with *Haplodontia* (pp. 263, 264).

Matthew, W. D.

1907. A Lower Miocene fauna from South Dakota. Bull. Amer. Mus. Nat. Hist., **23,** 169–219, 26 figs. in text.

Meniscomys sp. listed from Lower Rosebud (p. 172).

1910. On the osteology and relationships of *Paramys,* and the affinities of the Ischyromyidae. Bull. Amer. Mus. Nat. Hist., **38,** 43–72, 19 figs. in text.

Aplodontia and the Aplodontiidae considered in comparison and treatment of primitive rodents (pp. 44, 47, 48, 64–69, 71).

Merriam, C. H.

1886. Description of a new species of Aplodontia (*Aplodontia major,* sp. nov.) from California. Ann. N. Y. Acad. Sci., **3,** no. 10, pp. 312–328, 2 pls., 1 fig. in text.

Description of *Aplodontia major,* including discussion of history, nomenclature, habits, and variation.

1897. The mammals of Mount Mazama, Oregon. Mazama, **1,** 204–230.

Habits of *Aplodontia major* as observed on Mount Mazama, near Crater Lake (p. 219).

1899*a*. Descriptions of six new rodents of the genera *Aplodontia* and *Thomomys.* Proc. Biol. Soc. Wash., **13,** 19–21.

Original descriptions of *Aplodontia pacifica, A. phaea, A. olympica,* and *A. major rainieri.*

1899*b*. Results of a biological survey of Mount Shasta, California. U. S. Dept. Agr., Div. Biol. Surv., N. Amer. Fauna, **16,** 1–179, pls. 1–5, 46 figs. in text.

Aplodontia major rainieri listed as a Cascade species (pp. 74, 81); occurrence and habits of *Aplodontia major* on Mt. Shasta (pp. 92, 93).

MERRIAM, J. C.

1911. Tertiary mammal beds of Virgin Valley and Thousand Creek in northwestern Nevada. Part II, Vertebrate faunas. Univ. Calif. Publ. Bull. Dept. Geol., **6**, 199–304, pls. 32–33, 80 figs. in text.

Aplodontia alexandrae listed from Virgin Valley (p. 205); from Thousand Creek (p. 211).

1916. Tertiary vertebrate fauna from the Cedar Mountain region of western Nevada. Univ. Calif. Publ. Bull. Dept. Geol., **9**, 161–198, pl. 8, 48 figs. in text.

Aplodontia sp. from the Upper Miocene described (pp. 177–179).

MERRIAM, J. C., and SINCLAIR, W. J.

1907. Tertiary faunas of the John Day region. Univ. Calif. Publ. Bull. Dept. Geol., **5**, 171–205.

Four species of *Allomys* from the John Day beds are assigned to the Haplodontidae (p. 185).

MILLER, G. S., Jr.

1912. List of North American land mammals in the U. S. National Museum, 1911. U. S. Nat. Mus., Bull. **79**, xiv + 455.

Six forms of *Aplodontia* listed, as follows: *Aplodontia major major, A. m. rainieri, A. olympica, A. pacifica, A. phaea, A. rufa* (p. 291).

MILLER, G. S., Jr., and REHN, J. A. G.

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Six forms of *Aplodontia* listed, as follows: *Aplodontia major, A. m. rainieri, A. olympica, A. pacifica, A. phaea, A. rufa* (pp. 63–64).

MINDING, J.

1829. Ueber die geographische Vertheilung der Säugethiere. (Berlin, Enslin), pp. 1–104.

Refers genus *Anisonix* [=*Anisonyx*=*Aplodontia* (part)] to family Prensiculantia; genus includes species *brachyura* and "*rufa?*" (p. 86).

MUIR, J.

1909. Our national parks. (Boston, Houghton), x + 382 pp., numerous unnumbered plates.

Reference to *Haplodon* (p. 201).

MURPHY, J. M.

1876. The hunting fields of the Pacific Coast. Capturing the showtl. Rod and Gun, May 20, p. 121.

Habits of *Aplodontia leporina.*

1877. The shewelel or showtl. London Field, April 28, 486–487.

Habits of *Aplodontia leporina.*

MURRAY, A.

1866. The geographical distribution of mammals (London, Murray), xvi + 420 pp., 101 maps, numerous figs in text, numbered separately under chapters.

Reference to classification and habits of *Aplodontia leporina* (p. 263); additional references (pp. 356, 399, 401).

Newberry, J. S.

1857. Report upon the mammals, *in* Zoological Report, *in* U. S. Pac. R. R. Expl. and Surv., **6**, 35–72, 3 pls.

Remarks on distribution of *Aplodontia leporina* (p. 58).

Osborn, H. F.

1910. The age of mammals in Europe, Asia and North America. (New York, Macmillan), xvii + 635 pp., 220 figs. in text.

Superfamily Aplodontoidea; also family Aplodontiidae with three genera, *Meniscomys, Mylagaulodon, Aplodontia,* listed (p. 534).

Palmer, T. S.

1904. Index generum mammalium: a list of the genera and families of mammals. U. S. Dept. Agr., Div. Biol. Surv., N. Amer. Fauna, **23,** pp. 984.

Possible variations in generic name *Aplodontia* discussed (p. 25); genus *Aplodontia* (pp. 112–113); family names considered (pp. 744, 782, 841–842).

Peale, T. R.

1848. Mammalia and ornithology. U. S. Expl. Exp. (Wilkes) (Philadelphia, Sherman), **8,** i–xxvi, 17–338, several unnumbered figs. in text.

Aplodontia leporina discussed, and skull figured (pp. 56–57).

Peters, W.

1864. Neue Arten der Säugethiergattungen *Geomys, Haplodon,* und *Dasypus.* Mon. k. preuss. Akad. Wiss. Berlin, **1864,** 177–180.

Original description of *H[aplodon]. leporinus* var. *californicus.*

Price, W. W.

1894. Notes on a collection of mammals from the Sierra Nevada Mountains. Zoe, **4,** 315–332.

Habits and distribution of *Aplodontia major* (p. 328).

Rafinesque, C. S.

1817. Descriptions of seven new genera of North American quadrupeds, *in* Museum of Natural Sciences, *in* Amer. Monthly Mag. and Crit. Rev., **2,** 44–46.

Original description of *"Anisonyx? rufa"* (p. 45).

Richardson, J.

1829*a*. On Aplodontia, a new genus of the order Rodentia, constituted for the reception of the sewellel, a burrowing animal which inhabits the northwestern coast of America. Zool. Jour., **4,** 333–337.

Original description of genus, and of species *leporina.*

1829*b*. Fauna Boreali-Americana. (London, Murray), Part I, xlvi + 300 pp., 28 pls.

Descriptive remarks; genus *Aplodontia* (p. 210); species *leporina* (pp. 211–213); cranium, foot, and tooth figured (figs. 7–14, pl. 18C, opp. p. 197).

1837. Report on North American zoology, *in* Rep. 6th meeting Brit. Assoc. Adv. Sci., **5,** 121–224.

Apluodontia leporina listed (p. 150).

Schinz, H.

1845. Synopsis Mammalium (Solothurn, Jent), **2,** 1–574.

Compiled account of *Aplodontia leporina* (pp. 138–139).

SCHLOSSER, M.

1884. Die Näger des europäischen Tertiärs. Palaeontographica, **31**, 19–161, 16 numbered, several unnumbered, figs. in text, pls. 5–12.

Abstract of Winge's Jordfundne og nulevende Gnavere (Rodentia) fra Lagoa Santa, Minas Geraes, Brasilien, E. Museo Lundii, *in* Verzeichniss der anthropologischen Literatur, Archiv. f. Anthrop., **19**, 89–90.

Haplodontidae and *Haplodon* mentioned (p. 89); *Haplodon* (p. 90).

SCOTT, W. B.

1913. A history of land mammals in the western hemisphere (New York, Macmillan), xiv + 693 pp., frontisp., 304 figs. in text.

Aplodontia rufa mentioned (pp. 153, 233); Aplodontiidae (p. 249).

SINCLAIR, W. J.

1903. A preliminary account of the exploration of the Potter Creek Cave, Shasta County, California. Science, n.s., **17**, 708–712.

"*Aplodontia* either a new species or a new subspecies of *A. major*" listed (p. 711).

1905. New mammalia from the quaternary caves of California. Univ. Calif. Publ. Bull. Dept. Geol., **4**, 145–161, pls. 19–23, 2 figs. in text.

Original description of *Aplodontia major fossilis* (p. 147).

STEPHENS, F.

1906. California mammals. (San Diego, West Coast Publishing Co.), 351 pp., frontisp., many unnumbered figs. in text.

Family Aplodontidae, genus *Aplodontia,* and two species, *major* and *phaea,* discussed (pp. 93–95).

STONE, W., and CRAM, W. E.

1902. American animals. (New York, Doubleday), xxiii + 318 pp., many unnumbered illustrations.

Family Aplodontidae and species *Aplodontia rufa* discussed (pp. 150–151).

SUCKLEY, G.

1860. Report, *in* Zool. Rep., U. S. Pac. R. R. Expl. and Surv., **12**, bk. 2, pt. 3, no. 2, chap. 2, pp. 89–106.

Remarks on, and description and habits of, *Aplodontia leporina* (p. 100).

SUCKLEY, G., and GIBBS, G.

1860. *Op. cit.*, chap. 3, pp. 107–139, pls. 2, 5, 7, 9, 15.

Distribution of *Aplodontia leporina;* habits, Indian traditions (pp. 124–126).

SWAINSON, W.

1835. On the natural history and classification of quadrupeds. (London, Longmans), viii + 397 pp., 176 figs. in text.

Aplodontia (genus) discussed; *Ap*[*lodontia*]. *leporina* mentioned (p. 388).

TAYLOR, W. P.

1914. A previously undescribed *Aplodontia* from the middle north coast of California. Univ. Calif. Publ. Zool., **12**, 297–300.

Original description of *Aplodontia nigra.*

1916*a*. *Aplodontia humboldtiana:* a new mountain beaver from the Humboldt Bay district, California. Proc. Biol. Soc. Wash., **29,** 21–24.

Original description of *Aplodontia humboldtiana.*

1916*b*. The status of the beavers of western North America, with a consideration of the factors in their speciation. Univ. Calif. Publ. Zool., **12,** 413–495, figs. A–Q in text.

Paragraph on the Aplodontiidae (pp. 470, 471).

1916*c*. Two new aplodontias from western North America. Univ. Calif. Publ. Zool., **12,** 497–501.

Original descriptions of *Aplodontia rufa grisea* (p. 497), and *Aplodontia californica columbiana* (p. 499).

Thomas, O.

1896. On the genera of rodents: an attempt to bring up to date the current arrangement of the order. Proc. Zool. Soc. London, **1896,** 1012–1028.

Places *Anomalurus* and *Aplodontia* in groups by themselves, specifically providing that their true relationships will have to be shown by further research (p. 1014).

Townsend, C. H.

1887. Field-notes on the mammals, birds and reptiles of northern California. Proc. U. S. Nat. Mus., **10,** 159–241.

Discussion of *Haplodon rufus* (pp. 174–175); mention made of *H. major* (footnote, p. 174).

Trouessart, E. L.

1897. Catalogus mammalium tam viventium quam fossilium. (Berlin, Friedländer), tome 1, fasc. 2, pp. 219–452.

Lists two species of *Aplodontia,* namely [*Aplodontia*] *rufa* and [*Aplodontia*] *major* (p. 450).

1904. Catalogus mammalium tam viventium quam fossilium. Quinquenalle supplementum: Rodentia, fasc. 2, pp. 289–546.

Lists seven forms of *Aplodontia,* namely [*Aplodontia*] *rufa* [*A. r.*] *californica,* [*A. r.*] *rainieri,* [*A.*] *pacifica,* [*A.*] *phaea,* [*A.*] *olympica,* [*A.*] *major* (p. 348).

True, F. W.

1885. A provisional list of the mammals of North and Central America, and the West Indian Islands. Proc. U. S. Nat. Mus., **7,** App., 587–611.

Reference to family Haplodontidae and to *Haplodon rufus* (p. 596).

Tullberg, T.

1896. Zur Anatomie des *Haplodon rufus.* Zooliska Studier (Upsala, Almquist), pp. 231–251, 2 pls.

Anatomy and remarks on classification (p. 250).

Wagler, J.

1830. Natürliches System der Amphibien mit vorangehender Classification der Säugethiere und Vögel (Munich, Cotta), vi + 354 pp., 2 tables.

Haplodon listed (p. 4); sewellel (p. 22).

Wagner, J. A.

1843. Die Säugethiere [Schreber]. Supplementband, **3.** Abt., pp. xiv + 614.

Haplodon characterized; *Haplodon leporinus* discussed (pp. 395–396).

WALLACE, A. R.
1876. The geographical distribution of animals. 2 vols. (London, Macmillan), 2, viii + 607, 2 maps, 7 pls.

WEBER, M.
1904. Die Säugetiere (Fischer, Jena), xi + 866 pp., 567 figs. in text.
Aplodontia referred to "Familie" Haplodontoidea (p. 496).

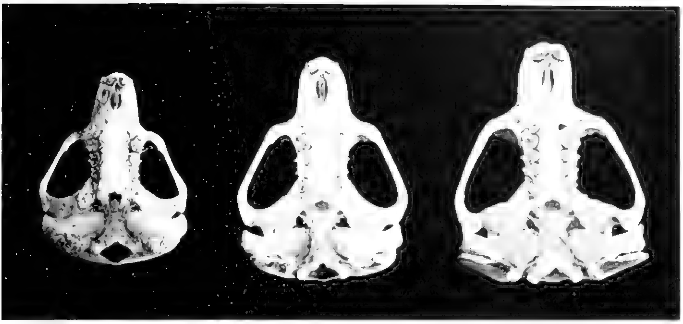
WINGE, H.
1888. Jordfundne og nulevende Gnavere (Rodentia) fra Lagoa Santa, Minas Geraes, Brasilien. E. Museo Lundii., 3, 1–200, pls. 1–8.
Haplodontidae (pp. 108, 110, 115, 135, 189); *Haplodon* (pp. 108, 115, 164, 189); relationships of rodent families (p. 110); Haplodontidae thought to be derived from Ischyromyidae, and Anomaluridae and Sciuridae derived from Haplodontidae.

ZITTELL, K. A.
1894. Traité de paléontologie. I. Paleozoologie: 4. Vertebrata; mammalia. (Paris, Doin), xi + 806 pp., 591 figs. in text.
Haplodontidae referred to Protrogomorpha (p. 523).

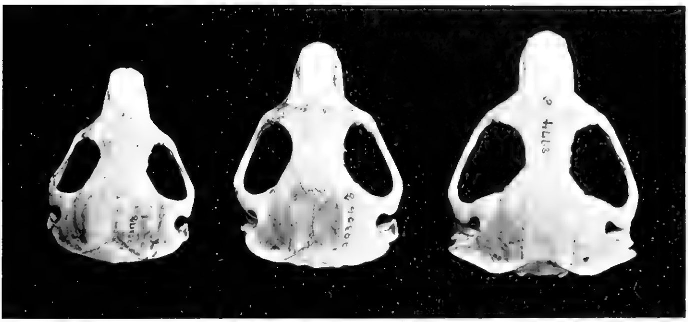
EXPLANATION OF PLATE 25

Crania of *Aplodontia rufa phaea,* to show some of the changes which take place with age; × 0.67. Figs. 1*a*, 1*b*, 1*c*, no. 20317, Mus. Vert. Zool.; figs. 2*a*, 2*b*, 2*c*, no. 20306, Mus. Vert. Zool.; figs 3*a*, 3*b*, 3*c*, no. 8974, Mus. Vert. Zool.

Note in the crania dorsally the disproportionate expansion of the skull, particularly posteriorly; the marked reduction in width of the interorbital constriction; and the disappearance of sutures. In the crania ventrally note the increase in measurements, the disappearance of sutures, and the disproportionate lateral growth of the mastoid processes as compared with the audital tubes; but note that the distance across the palate between the fourth premolars remains nearly constant. In posterior view note the disproportionately rapid outgrowth of the mastoid processes, with consequent disappearance of audital tubes, the change in outline of the foramen magnum, and the change in outline of the entire posterior aspect of the cranium, due to the development of the lambdoidal ridges and the outgrowth of the mastoid processes.



1a 2a 3a



1b 2b 3b

1c 2c 3c

EXPLANATION OF PLATE 26

Dorsal view of crania of woodchuck, aplodontia, and beaver; all $\times$ 0.50. Fig. 4, *Marmota flaviventris sierrae,* no. 15165, Mus. Vert. Zool.; fig. 5, *Aplodontia rufa californica,* no. 18663, Mus. Vert. Zool.; fig. 6, *Castor subauratus subauratus,* no. 12654, Mus. Vert. Zool.

Note in *Aplodontia* and *Castor* the absence of postorbital processes on the frontal; also the comparative width of the cranium posteriorly in *Aplodontia,* as compared with *Marmota* and *Castor.*

4 5 6

EXPLANATION OF PLATE 27

Figs. 7, 8.—Anterior view of crania of sciurid type and aplodontid type, to illustrate difference in infraorbital arrangement; × 0.77. Fig. 7, *Marmota flaviventris sierrae*, no. 15165, Mus. Vert. Zool.; fig. 8, *Aplodontia rufa californica*, no. 18663, Mus. Vert. Zool.

Note in *Marmota* the broadly expanded fossa for the masseter muscle just laterad of the infraorbital foramen on either side; note also the compression and reduction in size of the infraorbital foramen in this genus; note, on the other hand, the generalized character of the region in *Aplodontia*, there being no provision for the masseter muscle anterior of the ventral border of the anterior root of the zygomatic arch, and the infraorbital foramen being comparatively large, much as in the Eocene rodent family Ischyromyidae.

Figs. 9, 10. Dorsal view of mandibles of aplodontid and sciurid, to illustrate different development of angular processes; × 0.66. Fig. 9, *Marmota flaviventris sierrae*, no. 15165, Mus. Vert. Zool.; fig. 10, *Aplodontia rufa californica*, no. 18663, Mus. Vert. Zool.

Note the lateral expansion of the angle in *Aplodontia* as compared with *Marmota*.

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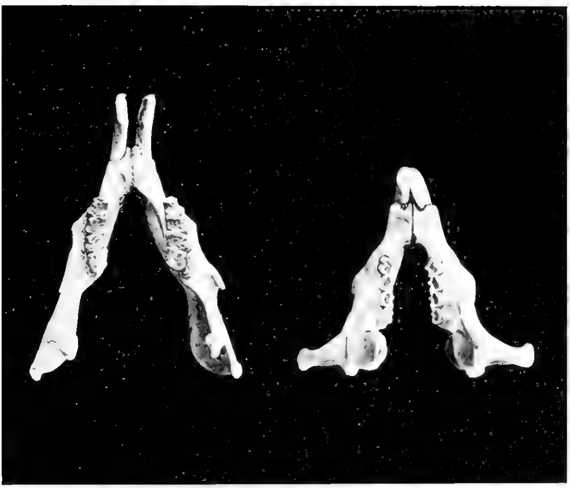
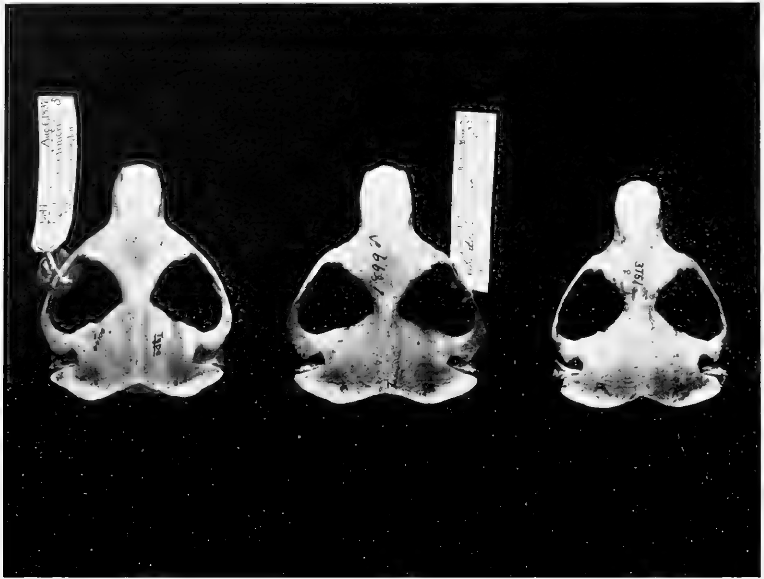


9 10

EXPLANATION OF PLATE 28

Dorsal view of crania of three subspecies of *Aplodontia;* × 0.54. Fig. 11, *Aplodontia rufa rainieri,* no. 90144, Biol. Surv. Coll.; fig. 12, *Aplodontia rufa columbiana,* no. 1899, Mus. Comp. Zool.; fig. 13, *Aplodontia rufa rufa,* no. 3751, Mus. Vert. Zool.

Note the general similarity in size between *Aplodontia rufa rainieri* and *A. r. columbiana,* with the latter somewhat the larger; note the heavier zygomatic arch in *columbiana* as compared with either of its neighbors, together with the greater expansion of the arch near the posterior root. Note the tendency in *rainieri* and *columbiana* to have temporal ridges closer together than in *Aplodontia rufa rufa.* Note in the latter the general smaller size and lighter zygomatic arch as compared with the mountain subspecies.

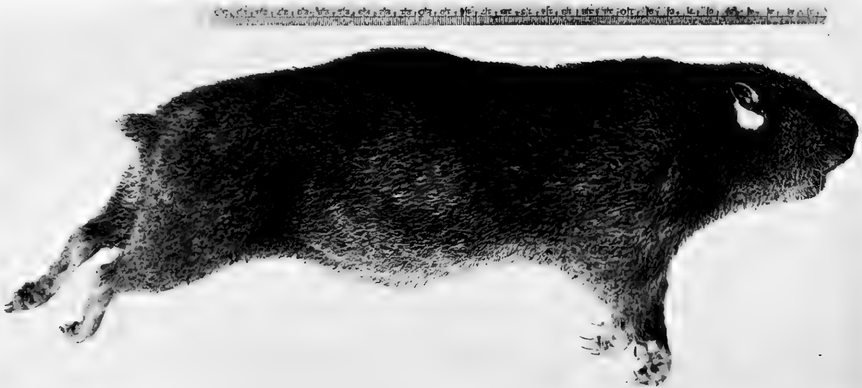


11 12 13

EXPLANATION OF PLATE 29

Study of fresh specimen of *Aplodontia rufa californica;* male, no. 22618, Mus. Vert. Zool.; East Fork Indian Cañon, Yosemite National Park, California; June 19, 1915; × 0.35.

Note the small ear with white spot at base, the short tail, the chunky body and blunt head.



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THE SUBSPECIES OF THE MOUNTAIN CHICKADEE

BY
JOSEPH GRINNELL

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THE SUBSPECIES OF THE MOUNTAIN CHICKADEE

BY
JOSEPH GRINNELL

(Contribution from the Museum of Vertebrate Zoology of the University of California)

Fieldwork was carried on by the California Museum of Vertebrate Zoology during 1917 in the Inyo region of eastern California. In going over the collection of birds obtained, the attention of the writer was arrested by certain peculiarities evident in the Mountain Chickadees. Comparison with series from the Sierras showed the Inyo birds to be paler colored and longer tailed; and in order to appraise these differences in taxonomic terms it became necessary to assemble material representative of the entire range of the species, in so far as possible. The results of the study thus undertaken are presented herewith.

The material involved in the inquiry has amounted to 464 skins of the Mountain Chickadee, derived from the following sources other than the Museum of Vertebrate Zoology: United States National Museum, through Dr. Charles W. Richmond; United States Biological Survey, through Mr. Edward W. Nelson; and the private collections of Messrs. Edward R. Warren, Joseph and John W. Mailliard, G. Frean Morcom, Harry S. Swarth, and J. Grinnell.

As of general interest, and in the nature of an introduction to the systematic analysis to follow, it may be stated that *Penthestes gambeli* including its subspecies is throughout its range non-migratory, save as a few individuals in pairs or small companies occasionally descend in fall or early winter to lower levels closely adjacent to their mountain habitats. The range of the species roughly extends from and includes the Rocky Mountains to or nearly to the Pacific Coast, and from Alberta and British Columbia south nearly to the Mexican line—somewhat south of it in northern Lower California. Within this general area the Mountain Chickadee is by no means uniformly distributed. Especially towards the south is its range very "spotty," the representations on detached mountain tops being wholly isolated. Two main areas of relatively continuous distribution are, however, perceivable—the Rocky Mountain area; and the Sierra Nevada area.

Close scrutiny of the series of specimens at hand well representing the entire Rocky Mountain area reveals no variation in phylogenetic characters from the northernmost to the southernmost stations. All show in apparently equal degree the long tail and cinnamon tinge of sides and back, these features together constituting the grounds for separate subspecific recognition of a Rocky Mountain form. On the other hand, the Sierra Nevadan center, with its own recognizable race,

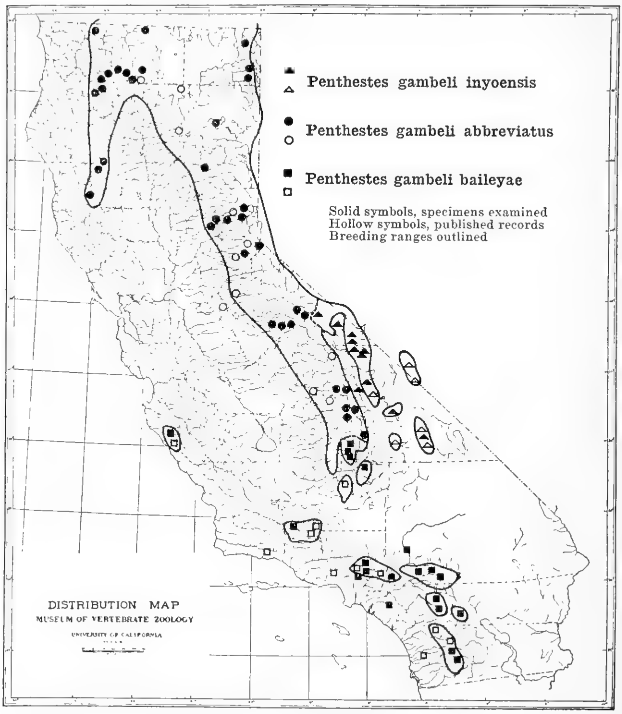
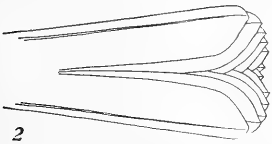


Fig. 1. Map showing distribution of the races of the Mountain Chickadee **in** California.

of relatively short tail, proves to have two outlying divergent forms. These three forms are alike in their lack of any cinnamon tinge, this being replaced in two of them by a buffy tinge and in one form by leaden gray. The tail in one of the outlying forms is long, in the other short. The habitats concerned are, respectively, the desert mountains of the Inyo region of eastern California, and the coastal mountains of southern California. This differentiation within the Pacific district, particularly within the state of California, will be better understood in its geographic bearing by reference to the accompanying map (fig. 1).

The behavior of the tail of *Penthestes gambeli*—long in the Rocky Mountain district, short in the Pacific district (see figs. 2, 3)—is paralleled in the *Penthestes atricapillus* group of chickadees across the North American continent in about the latitude of the state of Wash-



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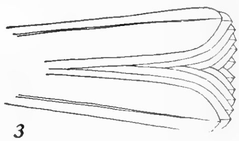

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Fig. 2. Tail of *Penthestes gambeli gambeli* (no. 27784, Mus. Vert. Zool.; ♂, full-grown juv.; Sierra Ancha, Gila Co., Arizona; June 26, 1917). × 1.00.

Fig. 3. Tail of *Penthestes gambeli abbreviatus* (no. 24059, Mus. Vert. Zool.; ♂, full-grown juv.; Yolla Bolly Mt., Tehama Co., California; August 5, 1913). × 1.00.

ington. In the northern Rocky Mountains occurs the race *P. a. septentrionalis,* with long tail; in the Pacific Coast strip of Washington and Oregon occurs the race *P. a. occidentalis,* with, among other characters, relatively short tail. Other parallels are to be found in the genera *Psaltriparus, Thryomanes* and *Pipilo.*

It is improbable that the fact of subspecific differentiation in *Penthestes gambeli* has been altogether overlooked previous to the present time. A premonition of the geographic variation now formally pointed out is to be found in the early writings of Baird (1858, p. 394), who remarked that "a specimen, apparently of this species [*Parus montanus*], from Medicine Bow creek [Wyoming], (5643,) though marked female, is larger than those from California, as shown by the measurements." Also, some of the differences in proportions in the subspecies now recognized are shown in the table of measurements given by Ridgway (1904, p. 409).

For a detailed description of the Mountain Chickadee as a *species,* the reader is referred to Ridgway (1904, p. 408).

Penthestes gambeli gambeli (Ridgway)

Rocky Mountain Chickadee

Parus montanus Gambel (1843, p. 259); and of authors, part. This name preoccupied (see Ridgway, 1904, p. 409).

Parus gambeli Ridgway *in* American Ornithologists' Union Committee (1886, p. 335); and of authors, part. Substitute name.

Parus gambeli thayeri Birtwell (1901, p. 166). Based on adventitiously colored specimen from Albuquerque, New Mexico. Type in United States National Museum.

Penthestes gambeli, of authors, part.

Type locality.—Santa Fé, New Mexico.

Diagnosis.—Among the four subspecies of *Penthestes gambeli* here recognized, color alone is sufficient for distinguishing *P. gambeli gambeli.* The flanks, sides of body and back in this form are pervaded with a distinct tinge of cinnamon—more exactly, the "pinkish buff" of Ridgway (1912, pl. 29). In addition, this race shows the greatest length of tail, and slenderest bill.

Measurements.—Average of 14 males: Wing, 70.5 mm.; tail, 70.2; exposed culmen, 8.6; depth of bill at base, 3.8. For extremes, see accompanying table.

Note.—In this paper the length of wing is the usual chord of the folded wing as dried at the side of the body in the conventional study skin. The tail length, however, is measured from the *base* of the uropygium to the tip of the longest pair of rectrices. It is found that in preparing specimens there is a practically uniform place for cutting off from the body the uropygium with attached feathers, and this is exactly where the tail bends back at an angle to the body in the fresh bird. The lateral rectrices are rooted evenly with the base of the dried uropygium so that the measurement of tail length thus taken becomes the distance from the extreme proximal ends of the most lateral pair of rectrices to the tips of the central pair—somewhat greater than the length of tail as given by Ridgway (1901, p. xv), the latter being the measurement from the base of the central pair of tail feathers to the tips of same. My reason for adopting this different procedure here is that more accuracy seems possible thereby, at least in the kind of material here dealt with. There is less mussing of the specimen also.

Neither depth of bill nor culmen is a practical index to degree of slenderness of bill. No ordinary method of measurement will suffice to indicate the facts as they are perceived by the eye.

As will be seen by the dates in the tables, as a rule only unworn specimens have been selected for measurement.

Range.—The Rocky Mountain region of North America, from eastern British Columbia and western Alberta south to western Texas, New Mexico and Arizona. *Specimens examined,* 72, from the following localities:

Alberta: Smoky Valley, 50 miles north of Jasper House, 1; Henry House, 1; 15 miles west of Henry House, 1.

British Columbia: South fork of Moose River, 1.

Montana: Gallatin County: Jefferson River, 1; Madison River, 2; Hillsdale, 2; Mystic Lake, 1; Dry Creek, 1.

Idaho: Sawtooth Lake, 1.

Wyoming: Mammoth Hot Springs, 3; Jackey's Creek, 4 miles southwest of Dubois, 1; Teton Pass, 7200 ft., 2; Salt River Mts., head of Dry Creek, 9200 ft., 1; Medicine Bow Mts., 10,200 ft., 1; Medicine Bow Creek, 1.

Utah: Filmore, 1.

Colorado: Loveland, 1; Middle Park, 1; Sangre de Christo Pass, 1; Fort Garland, 1; Platte Canyon, 1; Pueblo, 2; Estes Park, 1; Boulder, 2; Gold Hill, 1; Golden, 7300 ft., 1; Colorado Springs, 5; Querida, Custer County, 1; Salida, Chaffee County, 1; Crested Butte, Gunnison County, 1; Stamford, 1.

Texas: Guadalupe Mts., 6800 ft., 1; Davis Mts., 1.

New Mexico: Fort Massachusetts, 1; Fort Wingate, 1; Albuquerque, 1; Taos Mts., 8800 ft., 1; Manzano Mts., 4; Magdalena Mts., 7000 ft., 1; Cienequilla, 1; Mt. Capitan, 1; Pecos Baldy, 1; Bear Spring Mts., 1; Shiprock, 1; Corona, 1; Twining, 12,500 ft., 1; Fulton, 1; San Mateo Mts., 9500 ft., 1.

Arizona: Fort Whipple, 1; Mt. Graham, 1; San Francisco Mt., 2; Bright Angel Spring, Kaibab Plateau, 1; Canyon Spring, 1; Santa Catalina Mts., 2; Sierra Ancha, 6500 ft., 1.

Penthestes gambeli inyoensis, new subspecies

Inyo Mountain Chickadee

Parus gambeli, of authors, part.
Penthestes gambeli, of authors, part.
Penthestes gambeli baileyae, American Ornithologists' Union Committee (1910, p. 351), part (?).

Type locality.—Panamint Mountains (northern part), 3 miles east of Jackass Spring, 6200 feet altitude, Inyo County, California. *Type*, male adult, no. 28782, Mus. Vert. Zool.; October 7, 1917; collected by J. Grinnell, orig. no. 4588.

Diagnosis.—The palest colored race of the four; sides, flanks and back, in unworn plumage, pervaded with pale buff—the "cartridge buff" of Ridgway (1912, pl. 30). Wear or fading, or both, removes most of this buff tone, so that the resulting effect, in spring and summer birds, is of an ashy tone of coloration, distinctly lighter than in any of the other three subspecies, in same stage. It seems probable that there is a paler tone to the underlying plumage parts and that this becomes revealed by loss of the superficial pigment-bearing portions through the gradual progress of feather abrasion. *Inyoensis* shows nearly as long a tail as does *gambeli*. Its bill is somewhat smaller.

Measurements.—Average of 10 males: Wing, 71.1 mm.; tail, 69.3; exposed culmen, 8.1; depth of bill at base, 3.7. For extremes, see accompanying table.

Range.—The higher mountains of eastern California lying east and southeast of Owens Valley, from the vicinity of the Mono Craters and the White Mountains, in Mono County, south to the Panamint Mountains, in Inyo County. *Specimens examined,* 50, from the following localities, all in California:

Mono County: Mono Mills, 1; near Benton, 2; near Big Prospector Meadow, 10,000–10,500 ft., White Mts., 15; Cottonwood Creek, 9200 ft., White Mts., 1. Inyo County: Silver Canyon, 7000–8000 ft., White Mts., 8; Roberts Ranch, 8300 ft., White Mts., 1; head of Black Canyon, 8000 ft., White Mts., 2; Independence, 3900 ft., 1 (vagrant); Mazourka Canyon, 8000–10,000 ft., Inyo Mts., 3; near Jackass Spring, 6000–6200 ft., Panamint Mts., 14; Hanaupah Canyon, 7500–9000 ft., Panamint Mts., 2.

Penthestes gambeli abbreviatus, new subspecies

Short-tailed Mountain Chickadee

Parus montanus, of authors, part.
Parus gambeli, of authors, part.
Penthestes gambeli, of authors, part.

Type locality.—Horse Creek, Siskiyou Mountains (near Seiad Valley P. O.), Siskiyou County, California. *Type,* male, no. 119 (orig. no., in coll. J. Grinnell); December 12, 1901; collected by Malcolm P. Anderson.

Diagnosis.—Tone of color on sides, flanks and back the same as in *inyoensis,* though not quite so pale, namely, in fresh plumage, cartridge buff. Tail (see figs. 2, 3) much shorter than in either *gambeli* or *inyoensis;* and bill averaging smaller than in any of the other three races.

Measurements.—Average of 14 males: Wing, 69.7 mm.; tail, 65.0; exposed culmen, 7.9; depth of bill at base, 3.8. For extremes, see accompanying table.

Range.—The higher mountains of central and northern California, southern Oregon (probably this subspecies), and northwestern Nevada. Occurs west in northern California through the Siskiyou and Salmon mountains and to South Yolla Bolly Mountain and Mount Sanhedrin; and south in the Sierra Nevada to the vicinity of Mount Whitney. *Specimens examined,* 182, from the following localities:

California: Modoc County: Sugar Hill, 4; Warner Mts., 27. Siskiyou County: Mt. Shasta, 3; Jackson Lake, 5900 ft., 5; South Fork Salmon River, 5000 ft., 1; head of Rush Creek, 6400 ft., 2; Kangaroo Creek, 3; Castle Lake, 5400 ft., 1; Horse Creek, Siskiyou Mts., 11; Beswick, 1. Trinity County: head of Bear Creek, 6400 ft., 4; head of Grizzly Creek, 6000 ft., 6. Tehama County: near South Yolla Bolly Mt., 4. Mendocino County: near Castle Peak, 1; near Sanhedrin Mt., 4. Lassen County: Eagle Lake, 6. Plumas County: Meadow Valley, 1. Nevada County: Independence Lake, 3. Placer County: Summit, 1; Cisco, 6000 ft., 18; Blue Canyon, 4700–5000 ft., 12; Dutch Flat, 1. Eldorado County: Tahoe Valley, 2; Kyburz Station, 1. Mariposa County: vicinity of Yosemite Valley, 13. Mono County: Warren Fork of Leevining Creek, 9200 ft., 1; Williams Butte, 7500 ft., 1. Fresno County: Bullfrog Lake, 10,600 ft., 6. Inyo County (not typical): near Kearsarge Pass at 8500 ft., 1; Little Onion Valley, 7500 ft., near Kearsarge Pass, 1; Cottonwood Lakes, 11,000 ft., 7. Tulare County (not typical): Whitney Creek, 11,000 ft., 3; Whitney Meadows, 9800 ft., 14; Olancha Peak, 10,000 ft., 1.

Nevada: Pine Forest Mts., Humboldt County, 13.

Penthestes gambeli baileyae (Grinnell)

Bailey Mountain Chickadee

Parus montanus, of authors, part.
Parus gambeli, of authors, part.
Parus gambeli baileyae Grinnell (1908, p. 29).
Penthestes gambeli baileyae, American Ornithologists' Union Committee (1910, p. 351), part (?); and of authors.

Type locality.—Mount Wilson, 5500 feet altitude, San Gabriel Mountains, Los Angeles County, California. Type in coll. J. Grinnell.

Diagnosis.—Tone of coloration on sides, flanks and back distinctly plumbeous—more exactly, on sides and flanks the "smoke gray" of Ridgway (1912, pl. 46), and on back near the "mouse gray" of the same authority (pl. 51). The tail in this race is short as in *abbreviatus,* but the bill is long and heavy, averaging thicker through than in any of the other three races.

Measurements.—Average of 14 males: Wing, 70.0 mm.; tail, 65.4; exposed culmen, 8.5; depth of bill at base, 4.1. For extremes, see accompanying table.

Range.—Higher mountains of southern California, from the extreme southern Sierra Nevada in Tulare County, and the Santa Lucia Mountains in Monterey County, south to the Cuyamaca Mountains, San Diego County; also (probably this subspecies) in the San Pedro Martir Mountains, in northern Lower California. *Specimens examined,* 160, from the following localities, all in California:

Monterey County: Headwaters of Big Creek, 2. Ventura County: Mt. Pinos, 2. Kern County: Kiavah Mt., 7000 ft., near Walker Pass, 2. Tulare County (not typical): Taylor Meadow, 7000 ft., 8; Cannell Meadow, 7500 ft., 1; Pine Flat, 7500 ft., 1; Long Meadow, 7700 ft., 1; Sirretta Meadows, 9000 ft., 3; Trout Creek, 6000 ft., 10; near Trout Creek, 7500 ft., 2; Jackass Meadow, 7750 ft., 3; Troy Meadows, 8000 ft., 1. Los Angeles County: Mt. Wilson, 25; Buckhorn Canyon, near Mt. Waterman, 2; near Pasadena, 9 (vagrants); Verdugo, 1 (vagrant). San Bernardino County: near Cucamonga, 1; San Bernardino Mts., 35; Victorville, 3 (vagrants). Riverside County: San Jacinto Mts., 29; Thomas Mt., 1; Santa Rosa Mts., 10. Orange County: Santa Ana Mts., 3000 ft., 1 (vagrant?). San Diego County: Julian, 1; Cuyamaca Mts., 6.

General remarks.—In making use of the intrinsic color characters, which are important here in distinguishing subspecies, it is, of course, essential that the effects of extraneous factors be taken into account. Prolonged wear and fading evidently serve to weaken the intensity of the color tones, more especially the buffy ones. Then, too, chickadees seem peculiarly susceptible to discoloration by smoke, soot and charred wood; for example, our series from Cisco and Blue Cañon, stations along the Central Pacific Railway over the Sierra Nevada, even though taken in September and October almost immediately after completion of the fall molt, are obviously more or less begrimed with soot. On the other hand, the autumn- and winter-taken series from the Yosemite region and from the Siskiyou Mountains are clean, and show their intrinsic color tones to good advantage.

Intergradation undoubtedly connects the four races of the Mountain Chickadee into a continuous series of forms. Abundant material at hand from that portion of the Sierra Nevada immediately south of Mount Whitney shows complete transition from *Penthestes gambeli baileyae* to *P. g. abbreviatus;* in fact, many of the specimens can only be placed arbitrarily in one category or the other. Several examples from the vicinity of Mono Lake, in Mono County, California, and from along the west flank of the Sierras in Inyo County, insensibly bridge the interval between *P. g. abbreviatus* and *P. g. inyoensis,* especially when considered in connection with the individual variation to which each race is subject in about normal degree.

Material at hand from different parts of the Great Basin is unsatisfactory either in that it is scanty or because of the worn state of the plumage. A summer-taken series of 13 Mountain Chickadees (nos. 8952–8964, Mus. Vert. Zool.) from the Pine Forest Mountains, Humboldt County, Nevada, shows in color no approach to *P. gambeli gambeli.* In this respect it is like *P. g. inyoensis,* but the tail averages nearly as short as in *P. g. abbreviatus.* Taking all features into account it seems best placed under *abbreviatus.* Fresh-plumaged fall specimens from this locality would make determination more certain.

A specimen (♂, no. 547, Mus. Vert. Zool.) from Anthony, Baker County, Oregon, taken October 16, 1907, might be referred to *P. g. abbreviatus;* but the tone of color of back and sides is much darker than usual in that form. It is certainly much darker than in *P. g. inyoensis.* Its tail is but 65.3 mm. long. A skin (♀, no. 18, Morcom coll.) from Camp Harney, Harney County, Oregon, February 17, 1875, has a tail length of 67.7 mm., and in depth of color is about intermediate between *abbreviatus* and *P. g. gambeli.* A specimen (♀, no. 136639, U. S. Nat. Mus., Biol. Surv. coll.) from Fort Spokane, Lincoln County, Washington, September 28, 1890, is almost identical with *gambeli* in coloration; but it, too, has a short tail, only 64.4 mm. long, though there is chance of error here, as several of the rectrices are missing. The writer prefers to leave these last three examples for the time being unplaced.

It is clear that intergradation between *Penthestes gambeli gambeli* and any one of the other three subspecies is less well established than between any two of these other three. But sufficiency of material from the proper localities through eastern Oregon and eastern Washington would likely prove its existence as is the case between the California forms.

Measurements (in Millimeters) of Selected Specimens Representing the Four Races of *Penthestes gambeli*

Penthestes gambeli gambeli

U. S. N. M. no.	Sex	Date	Locality	Wing	Tail	Exposed culmen	Depth of bill
160697	♂	Nov. 24, 1892	Boulder, Colo.	71.7	71.2	8.8	4.0
109948	♂	Oct. 8, 1886	Pueblo, Colo.	72.0	72.4	8.4	3.9
109949	♂	Oct. 5, 1886	Pueblo, Colo.	70.9	70.3	8.5	4.0
176650	♂	Sept. 23, 1888	Madison R., Gallatin Co., Mont.	68.0	67.8	8.9	4.1
124151	♂	Sept. 15, 1888	Jefferson R., Gallatin Co., Mont.	69.7	67.7	10.0	3.6
188823	♂	Oct. 15, 1902	Mammoth Hot Springs, Wyo.	68.1	67.0	9.0	3.6
62546	♂	Nov. 17, 1872	Filmore, Utah	69.8	68.3	8.3	3.5
136638[1]	♂	Sept. 27, 1890	Sawtooth Lake, Idaho	68.1	69.7	8.8	3.8
228227[1]	♂	Sept. 14, 1910	Teton Pass, Wyo.	71.2	70.4	8.3	3.6
193086[1]	♂	Nov. 6, 1903	Manzano Mts., N. Mex.	71.4	70.6	7.8	4.0
184653[1]	♂	Oct. 22, 1902	Corona, N. Mex.	69.0	71.0	9.0	4.1
192942[1]	♂	Oct. 10, 1903	Twining, N. Mex.	72.0	71.4	8.5	4.0
136637[1]	♂	Sept. 18, 1889	San Francisco Mt., Ariz.	71.3	70.3	7.8	3.8
205661[1]	♂	Sept. 10, 1909	Kaibab Plateau, Ariz.	73.5	74.3	8.3	4.0

[1] Biol. Surv. Coll.

Penthestes gambeli inyoensis

Mus. Vert. Zool. no.	Sex	Date	Locality	Wing	Tail	Exposed culmen	Depth of bill
28751	♂	July 24, 1917	White Mts., Mono Co., Calif.	73.0	72.4	7.9	3.7
28760	♂	July 29, 1917	White Mts., Mono Co., Calif.	71.0	67.0	8.0	3.6
28766	♂	July 31, 1917	White Mts., Mono Co., Calif.	72.4	67.5	8.8	3.5
28767	♂	Aug. 18, 1917	White Mts., Inyo Co., Calif.	69.4	68.1	8.0	3.7
28770	♂	Sept. 29, 1917	Panamint Mts., Inyo Co., Calif.	68.8	69.8	8.1	3.7
28771	♂	Oct. 2, 1917	Panamint Mts., Inyo Co., Calif.	71.4	70.2	7.4	4.0
28773	♂	Oct. 2, 1917	Panamint Mts., Inyo Co., Calif.	72.7	71.0	8.4	3.8
28774	♂	Oct. 2, 1917	Panamint Mts., Inyo Co., Calif.	69.0	66.0	8.1	3.7
28781	♂	Oct. 5, 1917	Panamint Mts., Inyo Co., Calif.	71.0	70.0	8.3	3.7
28782	♂[1]	Oct. 7, 1917	Panamint Mts., Inyo Co., Calif.	72.0	71.5	8.4	3.5

[1] Type.

Penthestes gambeli abbreviatus

No.	Sex	Date	Locality	Wing	Tail	Exposed culmen	Depth of bill
114[1]	♂	Dec. 9, 1901	Horse Cr., Siskiyou Mts., Calif.	68.4	63.8	7.3	3.9
117[1]	♂	Dec. 12, 1901	Horse Cr., Siskiyou Mts., Calif.	69.0	64.7	7.9	3.7
119[1]	♂[2]	Dec. 12, 1901	Horse Cr., Siskiyou Mts., Calif.	70.0	65.0	7.8	3.6
129[1]	♂	Dec. 14, 1901	Horse Cr., Siskiyou Mts., Calif.	68.4	63.0	8.0	3.6
164[1]	♂	Dec. 29, 1901	Horse Cr., Siskiyou Mts., Calif.	69.0	64.2	7.2	3.9
178[1]	♂	Jan. 4, 1902	Horse Cr., Siskiyou Mts., Calif.	66.8	63.0	7.2	3.7
244[1]	♂	Feb. 16, 1902	Horse Cr., Siskiyou Mts., Calif.	70.8	65.0	7.3	3.6
23307	♂	Oct. 21, 1912	Blue Cañon, Placer Co., Calif.	71.8	69.5	8.2	3.9
23302	♂	Oct. 19, 1912	Blue Cañon, Placer Co., Calif.	71.2	64.3	8.8	4.1
23298	♂	Oct. 14, 1912	Blue Cañon, Placer Co., Calif.	71.6	65.7	7.8	3.5
25263	♂	Dec. 26, 1914	Yosemite Park, Calif.	69.8	65.9	8.4	3.8
25800	♂	June 11, 1915	Yosemite Park, Calif.	72.8	67.7	8.7	4.0
26117	♂	Oct. 22, 1915	Yosemite Park, Calif.	69.0	65.0	8.8	4.0
26342	♂	Nov. 27, 1915	Yosemite Park, Calif.	67.1	63.6	8.3	3.9

[1] Collector's original number, in Grinnell coll.; rest of numbers, Mus. Vert. Zool.
[2] Type.

Penthestes gambeli baileyae

No.	Sex	Date	Locality	Wing	Tail	Exposed culmen	Depth of bill
182[1]	♂	Nov. 29, 1895	Mt. Wilson, Los Angeles Co., Calif.	67.0	63.0	8.9	4.3
725[1]	♂	Nov. 1, 1897	Mt. Wilson, Los Angeles Co., Calif.	70.1	66.9	9.0	4.4
963[1]	♂	Oct. 31, 1898	Mt. Wilson, Los Angeles Co., Calif.	67.0	63.3	8.2	4.0
636[2]	♂	Feb. 1, 1896	Mt. Wilson, Los Angeles Co., Calif.	70.3	65.5	8.3	4.1
637[2]	♂	Feb. 1, 1896	Mt. Wilson, Los Angeles Co., Calif.	68.6	65.8	8.2	4.0
1832[2]	♂	Dec. 12, 1896	Mt. Wilson, Los Angeles Co., Calif.	72.3	65.7	7.7	4.0
1834[2]	♂	Dec. 12, 1896	Mt. Wilson, Los Angeles Co., Calif.	65.4	63.7	8.0	3.9
1836[2]	♂	Dec. 12, 1896	Mt. Wilson, Los Angeles Co., Calif.	67.7	63.0	....	4.0
5516[2]	♂[5]	Nov. 27, 1903	Mt. Wilson, Los Angeles Co., Calif.	72.1	66.6	8.6	3.9
6073[2]	♂	Sept. 21, 1904	Pasadena, Los Angeles Co., Calif.	69.7	66.0	9.0	4.3
7458[2]	♂	Dec. 23, 1905	Pasadena, Los Angeles Co., Calif.	70.0	66.7	7.8	3.6
9958[3]	♂	Oct. 31, 1897	Mt. Wilson, Los Angeles Co., Calif.	70.3	67.2	8.6	4.3
3364[3]	♂	Sept. 18, 1908	Santa Ana Mts., Orange Co., Calif.	70.8	66.0	9.5	4.0
x3325[4]	♂	July 4, 1905	Hd. of Big Cr., Monterey Co., Calif.	70.5	66.0	9.0	4.2

[1] Coll. H. S. Swarth.
[2] Coll. J. Grinnell.
[3] Mus. Vert. Zool.
[4] Coll. J. & J. W. Mailliard.
[5] Type.

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EXCAVATIONS OF BURROWS OF THE RODENT *APLODONTIA*, WITH OBSERVATIONS ON THE HABITS OF THE ANIMAL

BY

CHARLES LEWIS CAMP

UNIVERSITY OF CALIFORNIA PRESS

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(Contribution from the Museum of Vertebrate Zoology of the University of California)

CONTENTS

INTRODUCTION

While engaged in field work for the University of California Museum of Vertebrate Zoology the writer has had the opportunity of observing personally in the wild three of the California races of Aplodontia or Mountain Beaver. The notes of other members of Museum field parties have been available also in the preparation of this report, in fact all material, from whatever source, in the files of the Museum of Vertebrate Zoology. In addition, Mr. Alfred C.

Shelton, of the University of Oregon, furnished information which has been made the basis of some of the statements herein contained.

The writer wishes to thank Drs. Joseph Grinnell and Walter P. Taylor for bringing this paper into final form for publication.

Historical

Present knowledge of the mountain beaver began with the arrival upon the coast of Oregon of the expedition under Lewis and Clark. This expedition went into winter quarters at Fort Clatsop, near the present site of Astoria, on December 8, 1805. In Clark's notes (*in* Lewis and Clark, 1904, **3**, p. 279) of Friday, December 13, 1805, appears the following entry:

"The *Clatsops* leave us to day after a brackfast on Elk which they appeared to be very fond of before they left us they Sold me two robes of the skins of a Small animal about the size of a cat, and to Captain Lewis 2 Cat or Loucirva Skins for the purpose of makeing a Coat." The "small animal" mentioned was what the explorers thought the Indians called "Sewelel," if we are to judge by the notes of Lewis for February 15, 1806 (*loc. cit.*, **4**, p. 73), and February 26, 1806 (*loc. cit.*, pp. 109–110).

The first published account of the mountain beaver was a modification of the above notes in the Biddle-Allen edition (1814) of the Lewis and Clark Expedition (see Coues, 1877, p. 591). And the first naturalist to study a skin of the animal was Richardson (1829, pp. 211–213).

The Wilkes Exploring Expedition collected two specimens of aplodontia, probably in the neighborhood of Puget Sound. T. R. Peale (see Coues, *loc. cit.*), who collected these specimens and later (1848) described them, remarks on the abundance of the species at "Puget's Sound."

The next notice of the genus was by Audubon and Bachman (1854, **3**, pp. 99–102), who quote Richardson and Lewis and Clark as first published, and add inferences drawn from the anatomy as to the habits, and some further statements concerning distribution.

The naturalists of the Pacific Railroad Survey, under the supervision of S. F. Baird, were able to make valuable observations on the habits of aplodontia. Their findings together with those of other observers since then and up to the year 1916, are incorporated into the succeeding parts of the present paper.

Coues (1877, p. 591) reviews the literature on *Aplodontia* up to his time, making, however, no mention of Lord's interesting notes on the genus (1866, **1**, pp. 346–358).

The most important recent contribution to the life-history of aplodontia is comprised in the notes and photographs of Anthony (1916). This came to hand after the present paper had been prepared.

The writer has not had access to an article by Murphy (1876), of which he has heard.

For full systematic treatment of the genus *Aplodontia* and for lists of names, both vernacular and scientific, see Taylor (1918).

Habitat

Like the beaver and some of the ground squirrels, the aplodontia seems to be of social habits, congregating in more or less extensive colonies in localities where conditions favor its existence. If a real social bond exists it must be a primitive one. The scattered nature of most of the colonies proclaim this; and the probable absence of voice, which usually accompanies social habits, is suggestive.

The factors necessary for the existence of all the nine subspecies of *Aplodontia* now recognized seem to be: An abundant supply of certain food plants chiefly of riparian growth; and a soil at least moderately deep and firm, and with adequate drainage, where the animals can burrow. Hillside seepage areas and the banks of streams provide the usual situations of colonies. Colonies occurring in wooded and brushy places at a distance from water are sometimes inhabited only in the wet season (Shelton, MS, 1916), but if the food supply continues, such burrows may be used the year round.

Burrows

Wherever the aplodontia lives it digs extensive underground tunnels that in a populous colony form a network of passages a few inches beneath the surface of the ground (see fig. 1). Each burrow system has many openings to the surface, but excavated dirt and rubbish is pushed out usually at only a few of these holes. The three subspecies living along the coast of California invariably choose for the colony a spot within a dense tangle of ferns, thimbleberry and other low plants in wet or at least damp soil. So well concealed beneath tangled shrubbery are the unplugged burrows that the presence of the animals is often unknown to persons resident in even the immediate neighborhood.

The grouping of the burrows in close "companies" may simply indicate that the animals are not wont to range widely enough to invade adjacent districts, though these seemingly might support a population of similar extent. Overcrowded conditions may prevail in one place, while territory of the same character remains unoccupied near by. Near Point Reyes, in the gulches five miles west of Inverness, Marin County, California, trapping was carried on in 1913 in two colonies of *Aplodontia rufa phaea*. The burrows extended along

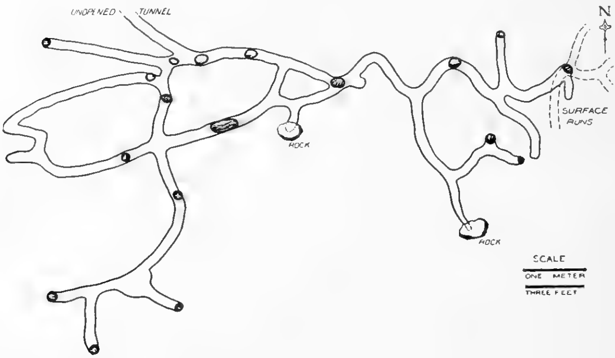

Fig. 1. Plan of underground tunnels in colony of *Aplodontia rufa phaea* excavated near Point Reyes, Marin County, California. All tunnels shown were within 600 millimeters of surface of ground.

the side of a low north-facing bluff among bare hills for two miles or more. One section of this colony in a rectangular area about 500 by 100 feet contained at least 100 burrow entrances. Here 169 "trap-nights" (one trap out one night equals one trap-night) in thirty-six burrow entrances produced eleven specimens. No individuals were secured in the last forty-six trap-nights, an indication, perhaps, that the catch approximated the total population of that part of the colony. Ninety-two trap-nights in another limited part of the above colony produced six specimens.

Some of the burrows in the Point Reyes locality were excavated by me (see figs. 1, 2). The floors of many of the runways were seen to be tramped hard from long use. It was found that nearly all the burrow entrances on the hillside were connected with one another by passages six to eighteen inches beneath the surface. At one point a nest was discovered half filling a globular chamber about a foot in diameter (see fig. 2). The nest was constructed for the most part of dry sword fern "leaves" stripped from the frond stem. It also contained a few large dry leaves of the cow parsnip, a plant nearly everywhere found in the vicinity of the burrows. Some dirt was mixed with the nest and the whole had been trampled down into a firm mass, flat on top.

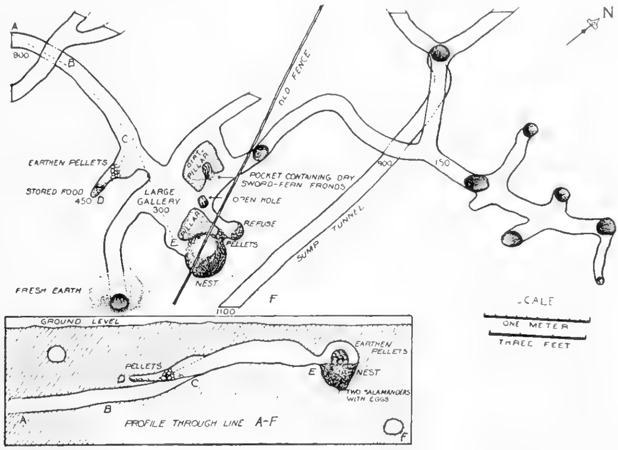

Fig. 2. Plan and partial elevation of nest-galleries of *Aplodontia rufa phaea* excavated near Point Reyes, Marin County, California. Numbers on plan indicate depth in millimeters beneath surface of ground.

Adjoining the nest chamber in the excavation mentioned, and opening into it, was a low square "room" twenty inches in diameter, the floor and sides of which showed signs of continued use by the inhabitants. Pockets near by contained stored roots, stems and leaves carefully blocked in by artificial earth pellets (see fig. 2).

Aplodontia rufa nigra, at Point Arena, Mendocino County, California, the closest relative of *A. r. phaea*, and *A. r. humboldtiana*, of the Humboldt Bay region and farther north, both apparently have burrow systems similar to that of *phaea* described above. Like *phaea*, *nigra* inhabits thimbleberry thickets. It lives on north-facing gulch sides in a small area (about twenty-four square miles) along the central Mendocino County coast. The colonies now known extend from the town of Point Arena to Alder Creek, seven and one-half miles north. In the case of the race *phaea* colonies occur in a part of the Point Reyes Peninsula and country adjacent, in Marin County, California, an area of not more than 110 square miles in all.

Of a colony of *Aplodontia rufa humboldtiana* discovered at Cuddeback, Humboldt County, California, Stephens (MS, 1910) says:

> I put ten traps in the burrows and did not cover more than half the entrances. I saw at least two tunnels run close under the surface, with frequent openings. My previous idea of a burrowing place for aplodontia is wet or springy land. This is far from that. It is a very steep south-facing slope almost at the top of a point on a high ridge and is as dry a place as well could be found. The location is in an open place in a thick forest of redwood, spruce, and fir. It has been burned over three years ago and there is very little underbrush.

Lyon (1907, p. 91), speaking of *Aplodontia rufa rainieri*, says: "The burrows or tunnels are about 8 to 9 inches in diameter and were always found in groups or colonies."

The habitat preferences and burrowing habits of *Aplodontia rufa rufa* appear to be similar to those of the California coast species. Matteson (1877, pp. 434–435) states that the mountain beaver of Oregon "is a digger *par excellence* and burrows into the sides of the hills usually in the neighborhood of a spring." Lum (1878, pp. 10–13) notes that the species of mountain beaver along the western base of the Cascade Mountains "usually selects the open glades of the forest, thickly grown up with fern and sallal" (*Gaultheria shallon*) for its burrows. "Here the ground will be seen perforated with holes. . . . Beneath the ground the various openings connect and form a perfect plexus of passages often nearly parallel with the surface and only a foot or so in depth. . . . In many places I found water coursing its way through the passages."

In California, at the southern part of its range, aplodontia usually prefers a shady, north slope for its burrows; but Brooks states (1899, pp. 258–259) that the race (*Aplodontia rufa columbiana*) in British Columbia, in the extreme northern end of the range of the genus, prefers a locality "where there is a good thick growth of vegetation on the mountain slopes, especially on those with a south exposure."

Aplodontia rufa californica of the Sierra Nevada, in California, has been found in a variety of situations, at elevations all the way from 5500 to 10,000 feet. Townsend (1887, pp. 174–175) saw burrows near Morgans Springs near Mount Lassen, and on the North Fork of the Feather River at Big Meadows. He says the burrows resembled those of muskrats and were in clayey banks. On Mount Shasta, Osgood (*in* Merriam, 1899, p. 93) found at most only a single pair of mountain beavers living in one place.

Price (1894, p. 328) notes that at the big-tree grove near Red Point, Placer County, "two small colonies were seen in boggy land about springs." Burrows were noted "in the bottom of a ravine among dense beds of moss, thickly shaded with tangled bushes."

Stephens (1906, pp. 94–95) speaks of burrows of California

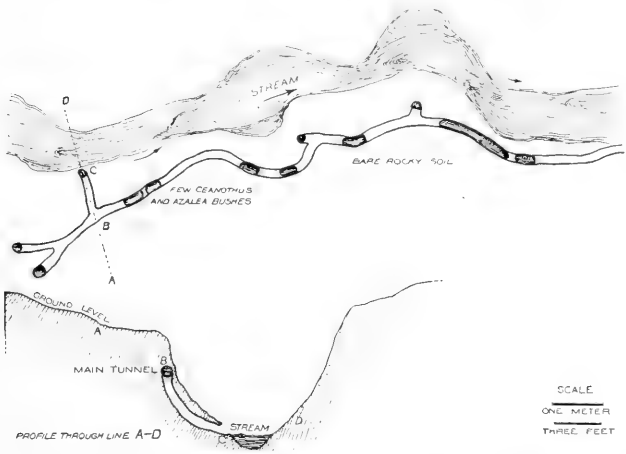

Fig. 3. Plan and partial elevation of burrow system of *Aplodontia rufa californica* excavated at Chinquapin, Yosemite National Park, California.

mountain beaver that were fifty yards or more in length. He observed the animals on the headwaters of the Carson River in Alpine County. Here, he says, they "live in wet springy land in canyons and on mountain sides where suitable springs occur, usually at considerable altitudes" [8000 feet]. Most of the entrances were under clumps of willow. Stephens also saw where watercourses had been diverted by the burrows.

Muir (1909, p. 201) describes how *Aplodontia rufa californica* in the Yosemite National Park "digs canals and controls the flow of small streams under the sod"; "and it is startling," he says, "when one is camped on the edge of a sloping meadow near the homes of these industrious mountaineers to be awakened in the still night by the sound of water rushing and gurgling under one's head in a newly formed canal.''

Grinnell (MS, 1912) observed *Aplodontia rufa californica* at Blue Cañon, Placer County, California. His notes in regard to their burrowing habits follow. ''It [the colony] is now [August 30] in rather

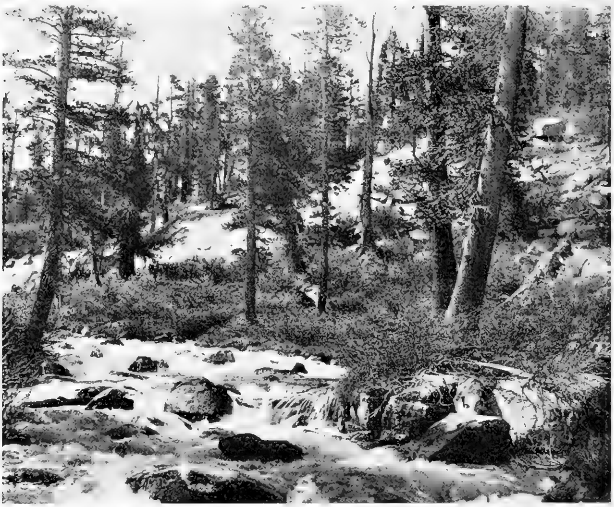

Fig. 4. Type of habitat in which ''colony'' of *Aplodontia rufa californica* was situated; 9700 feet altitude, head of Lyell Cañon, Yosemite National Park, California. The trees are lodgepole pines; the riparian growth is willow.

dry ground, though evidently wet most of the year; for it is overgrown with luxuriant thimbleberry and chokeberry. The whole place is densely shaded by black oaks and spruces. At the colony located I saw fully 15 fresh burrows.'' There were evident trails or surface runways out into the salmonberry bushes. Burrows were frequently coincident with water channels beneath the sod.

In the Yosemite National Park extensive thickets of the preferred food plants are scarce, and here the mountain beaver must as a rule be content with limited tunnel systems through the narrow willowfringes along the streams. At Chinquapin, 6200 feet altitude, in the Park, a tunnel (see fig. 3) of *Aplodontia rufa californica* was excavated for a distance of twelve yards along the steep bank of a stream without the discovery of a single side branch of importance. Only two individuals, male and female, were captured in this tunnel. The burrows in the colony at Chinquapin were far scattered along-stream owing to the narrowness of the area available to the animals. At many other localities in the Park similar conditions prevailed (see fig. 4). Small colonies with more complicated systems of runways are sometimes established where conditions will allow, as, for example, in willow thickets bordering meadows and, high up in the mountains, in Labrador tea and willows along creeks and about springs. In almost every colony tunnels were found containing running water. At one place the entire flow of a small stream was taken care of for some distance below ground.

The burrows of *Aplodontia rufa rufa* of the Trinity and Siskiyou mountains, to judge from the descriptions given by Kellogg (1916, pp. 369–372) and Alexander (MS, 1911), appear to be similar to the more simple type of tunnel system of *A. r. californica*. Even in one exceptional case where the ground was found to be ''literally honeycombed'' by burrows and runways, a ''main tunnel'' could be distinguished. As with *californica* never more than one pair of animals was secured from a single set of runways.

Food

A wide range of plant species is eaten by the mountain beaver. The number used for food at a single locality generally includes most of the species of shrubs and young trees within reach of the burrows. However, a marked preference is often shown for one particular plant. Those kinds with succulent stems, when available, take precedence over the more woody ones. The coast species of aplodontia are predominantly fern and root eaters. The following table provides record of the plants known to be eaten by various races of the mountain beaver.

TABLE SHOWING FOOD OF APLODONTIA ACCORDING TO SUBSPECIES AND LOCALITY

Authority	Locality	Plants
	Aplodontia rufa rufa	
Lum (1878), p. 11)	Oregon (?)	Ferns, salal, hazel, red clover, and roots
Shelton (MS, 1916)	Vicinity of McKenzie Bridge, Lane Co., Oregon	Mountain alder, "wild pea"
Alexander (MS, 1911)	South Fork, Salmon River, Siskiyou Co., California	Cut grass ("hay"), and green plants
Kellogg (1916, pp. 371–372)	Jackson Lake, Trinity Co., California	Alder and wild plum
	Aplodontia rufa olympica	
Elliot (1899, p. 252)	Olympic Mountains, Washington	A kind of lily
	Aplodontia rufa columbiana	
Brooks (1899, pp. 258–259)	Southern British Columbia	Scotch cap (*Rubus nutkanus*)
	Aplodontia rufa pacifica	
Heller (*in* Elliot, 1903, p. 184)	Gardiner and Florence, Oregon	Ferns, salal, and Oregon grape
Anthony (1916, p. 57)	Tillamook, Oregon	Thimbleberry, elk-brake, and sword-fern
Shelton (MS, 1916)	Oregon (west-central)	Salal, Oregon grape, vine maple, young firs (up to ¾ in. in diameter), sword-fern ("favorite food"), and wild rose
	Aplodontia rufa humboldtiana	
Stephens (MS, 1910)	Cuddeback, Humboldt Co., California	Laurel sprouts, ferns, and grass
	Aplodontia rufa nigra	
Camp (MS, 1913)	Point Arena, Mendocino Co., California	Sword-fern, cow-parsnip, stalks of nettle, cultivated "cow-peas and oat hay"
	Aplodontia rufa phaea	
Dixon (MS, 1909)	Lagunitas, Marin Co., California	Roots of mint
Camp (MS, 1913)	Five miles west of Inverness, Marin Co., California	Sword-fern (fronds and rootstocks), cow-parsnip, salmonberry, wild pea-vine, and chilicothe (leaves and roots)
Camp (MS, 1913)	Three miles south of Olema, Marin Co., California	Sword-fern and brake fern
	Aplodontia rufa californica	
Merriam (1899*b*, pp. 92–93)	Mt. Shasta, California	Ferns, willows, thimbleberry, mountain ash, and brake fern

Authority	Locality	Plants
Townsend (1887, pp. 174–175)	Feather River, California	Weeds and coarse grasses
Grinnell (MS, 1912)	Blue Canyon, Placer Co., California	Choke-cherry, willow, creek dogwood, and thimbleberry (*Rubus parviflorus*)
Allen (*in* Merriam, 1886, pp. 312–328)	Placer Co., California	Lily stems, willow, red osier, small fir trees, and manzanita
Price (1894, pp. 315–332)	Big-tree grove, 20 miles southeast of Red Point, Placer Co., California	Mountain cranberry stems (*Vaccinium occidentale*), *Ceanothus*, and *Rhododendron*, in large quantities
Stephens (1906, pp. 94–95)	Headwaters of Carson River, 8000 ft., Alpine Co., California	*Iris*, *Astragalus*, willow, and alder
Grinnell (MS, 1915)	West Fork of Indian Creek, 7250 ft., Yosemite National Park, California	Oct. 30, large quantities of "hay" out to dry consisting entirely of *Lupinus longipes*
Camp (MS, 1915)	Head of Porcupine Creek, above Porcupine Flat, 8400 ft., Yosemite National Park, California	Willow and aspen (limbs up to ½ inch in diameter)
Camp (MS, 1915)	One mile northeast Porcupine Flat, 9500 ft., Yosemite National Park, California	Labrador tea (*Ledum glandulosum*), and *Ribes viscosissimum*
Grinnell (MS, 1915)	Porcupine Flat, 8600 ft., Yosemite National Park, California	Willow bark, and young lodge-pole pines (terminal twigs only)
Storer (MS, 1915)	Head Lyell Canyon, 9800 ft., Yosemite National Park, California	Willow stems up to ⅝ inch in diameter
Camp (MS, 1915)	Chinquapin, 6200 ft., Yosemite National Park, California	Azalea (stems to 1 inch in diameter chewed), *Ribes*, *Cornus pubescens*, chinquapin, incense cedar, hazel, *Prunus* (sp.?), *Ceanothus cordulatus*, white fir, sugar pine, brake fern
Camp (MS, 1915)	One-half mile west Ostrander Rocks, 7500 ft., Yosemite National Park, California	*Cornus pubescens*, and *Ribes viscosissimum*.

In captivity the animal has been known to eat "apples and other fruit and vegetables" (Lum, 1878, pp. 10–13), celery, carrots, turnips, potatoes, cabbage, and lettuce.

Feeding Habits

Aplodontia is rarely seen in the daytime, but comes forth early in the evening in search of food and doubtless remains active throughout the night. Bretherton (1895, p. 124) mentions that he has trapped a large number without ever having seen one abroad in daylight. Our own observations as well as those of others confirm him. An individual of *Aplodontia rufa phaea* that the author kept captive built itself a nest where it remained passive in a sitting posture throughout the day.

Fig. 5. Entrance to burrow of *Aplodontia rufa phaea;* six miles west of Inverness, Marin County, California. Cutting of sword fern to be seen in mouth of burrow.

This rodent is slow and cumbersome in gait and seldom ventures far from its burrow. Tunnels are dug directly into suitable clumps of vegetation where the animals wish to forage, and from the burrow entrances issue short trails or runways along which the animal transports cut stems and leaves to the mouths of its burrow system. Occasional sections of cut material are dropped along these pathways, thus distinguishing them from the runways made by rabbits and ground squirrels (see fig. 5). Remains of fresh leaves and twigs pulled just within the burrow entrances lead one to believe that the timid mountain beaver does much of its feeding in the comparative security of its burrow.

A singular habit has been noticed in connection with the storage of food. In a burrow excavated at Point Reyes (see fig. 2) the entrances of two of the food storehouses were found plugged with large pellets of earth evidently manufactured by the animal for this especial purpose. These earthen balls were one to two inches in diameter and very hard and dry, evidently from having been handled a good deal. It is curious that the outer burrow entrances are not similarly plugged.

Gibbs (*in* Suckley, 1860, p. 100) was the first to note a peculiar hay-making habit among the mountain beavers he found living at the top of Yakima Pass, Washington. "Near their abodes," he says, "were small bundles of some herb or plant cut with nicety and laid out on logs to dry or wilt," and Lyon (1907, p. 91) and Bretherton (1895, p. 124) confirm this. Townsend (1887, pp. 174–175) thought he recognized the hay-making instinct among the aplodontia he observed on the North Fork of the Feather River in California. Elliot (1899, p. 252) makes particular notice of the hay-making habit and adds that the cured stems of the lily, which he saw *Aplodontia rufa olympica* using, may be employed either for food or as bedding in the nests. Stephens (1906, p. 95) writes: "I saw bunches of plants laid up on low bushes to dry, commonly over entrances to burrows, most of these not being much dried, as if they had carried them in as soon as they were well wilted"—this in regard to *Aplodontia rufa californica*, on the headwaters of the Carson River in Alpine County, California. Miss Kellogg (1916, p. 372) speaks of the habit in question as occurring among the colonies of *Aplodontia rufa rufa* discovered on the South Fork of the Salmon River in Siskiyou County, California. She says: "We found the mountain beavers making what we called 'hay'—large bunches of green plants of various kinds cut up and spread out as if to dry and to be used later."

From observations of the nests and of feeding habits my own conclusion is that the animal does not eat dried food but uses its hay for nest-building material.

The manner of feeding has been observed in the captive animal and partly determined from the evidence of cuttings. The rodent usually sits back upon its short tail, with the back curved, the hind feet extending out in front, soles forward, and the fore paws grasping the stem, root or leaf. The short first finger is used like a human thumb and the large callosities on the palms aid in holding an object so firmly that it can be retained easily in one hand. Stephens (1906, p. 95) says that the hind feet as well as the fore feet are used in grasping. Plants are harvested in sections from two to six inches in length so that they can be dragged into the burrows. Tough woody twigs and stems are chewed through from one side only, not in the manner in which beavers attack large trees. If the plant is a soft annual the whole stem is rapidly nibbled; if a perennial, the bark is chewed off in the manner of a beaver or porcupine and the wood discarded.

More than one writer since Lewis and Clark have mentioned the climbing habit of mountain beavers; and the evidence seems to be good that at least the Oregon and Washington coast species climb into low bushes for food (see Lum, 1878, pp. 10–13). The mountain beavers on the grounds of the University of Washington at Seattle have been seen climbing.

Hibernation

There seems to be no certain evidence that the mountain beaver hibernates even in the coldest part of its range. Cooper (1860, p. 82) affirms that these animals had been seen running over the snow in the Nisqually Valley, Washington. Suckley (*in* Suckley and Gibbs, 1860, p. 124) learned from the Nisqually Indians that the mountain beaver moves about a little during the winter but does "not become decidedly active till late in the spring." Lord (1866, pp. 346–358) maintains that the animal only partially hibernates—this of the species in British Columbia. Matteson (1877, pp. 434–435) believes that the mountain beaver hibernates, at that time covering the entrance of the burrow with stalks of leaves and fern. Bretherton (1895, p. 124) says that they do not hibernate.

Lum (1878, pp. 10–13) reports the following of the Oregon and Washington species: "They do not hibernate, but keep their burrows open all winter; beaten trails in the snow are often seen, leading above ground for a few feet from one hole to another. They are able to gather their food at any time of the year, seldom going more than a few feet from the entrance of their holes to procure it." Brooks (1899, p. 259) asserts that the aplodontia in British Columbia "does not hibernate at lower levels but must do so on the higher mountains, as it does not seem to make 'hay' like the Pika."

The California species of mountain beaver, even in the high mountains, are certainly active during the winter. Near Olema, in Marin County, *Aplodontia rufa phaea* has been trapped, at its burrow entrances, during the latter part of November. In the Yosemite National Park, at elevations of from 6200 to 8600 feet, winter work of *Aplodontia californica* has been observed—young pine, fir and cedar trees with the limbs trimmed off up to ten feet above the ground and with twigs trimmed from one side of the trunk only, as if worked on when the trees were bent down in the snow. Azalea

Fig. 6. Life study of *Aplodontia rufa californica;* Lyell Cañon, Yosemite National Park, California; July 17, 1915. Note the small eye and ear, the white spot at base of ear, the shortness of the tail, and the seemingly sluggish general apearance of the animal. The matted appearance of the hair on the back is due to moisture.

and other thickly growing bushes with the tops trimmed off evenly a foot or more above the ground indicate that the animals probably forage on top of the snow.

Scatology, Sanitation, and Drainage

The faeces are black, about the shape of those of a pocket gopher but larger (in *Aplodontia rufa phaea,* measuring 6 to 7 by 15 to 20 millimeters); the urine is yellow and cloudy. Faeces are rarely seen about the burrows; they are probably deposited in some particular place underground, but I have never succeeded in discovering any in the burrow systems excavated.

Arrangements are always made for the proper drainage of the burrows, and in wet hillsides water often runs continuously from the lower tunnels. In some places the courses of streams are diverted, though perhaps accidentally. The mountain beaver is not aquatic in any true sense, but is often caught in traps set in the water running through the burrows. The animal is said to dip its fore feet in water and to wash its head.

Sense Perception

Sight and hearing seem to be relatively defective in the mountain beaver (see fig. 6). The individual comes in contact with its underground environment chiefly through the sense of feeling, and this is markedly developed all over the body. The slightest touch upon a hair will be responded to instantly by quick jerking movements. The sense of smell seems to be good, for the animal has a way of frequently raising its nose to sniff; also the scent glands are well developed.

Breeding Habits

Almost nothing is known concerning the breeding habits of any of the forms of this interesting genus. Lord (1866, pp. 346–358), speaking of *Aplodontia rufa columbiana* as observed upon the banks of the "Chilukweyuk River" in British Columbia, asserts that the female has from four to six young at a birth and about two litters a year; and that the nest is like a rabbit's, made of grass and leaves, and is placed at the end of a deep burrow. Lum (1878, pp. 10–13) writes that "People living in the vicinity of these animals [*A. r. rufa*?, in Oregon?] tell me that the young show'tls just weaned make their appearance during the month of June in numbers from three to five at a birth."

Voice

The only sound that we have known the mountain beaver to make is a singular grating noise produced when the animal is alarmed, by rasping the lower incisors laterally across the tips of the upper. I have seen pocket gophers, marmots, and copper-headed ground squirrels (*Callospermophilus*) do the same when terrified.

Aplodontia has been credited with a real voice, but the chances for error in most of the following reported observations in this regard are very great. Suckley and Gibbs (1860, p. 124) quote a certain Colonel Simmons as saying that he had seen mountain beavers "sitting at the entrances of their burrows early in the morning and whistling, something in the manner of the prairie-dog." Lord (1866, pp. 346–358) heard whistlings in the evening which he attributed to these animals. Matteson (1877, pp. 434–435) reports that the aplodontia in Oregon "is generally known as Mountain Boomer from his habit of making a kind of booming noise." Lum (1878, pp. 10–13) has never known it to make any sound by day or night, "save a kind of growl when caught in a trap." Price (1894, pp. 315–332) speaks of a shrill cry heard several times when he was near a colony of mountain beaver.

Enemies

Most writers agree with my own conclusion that aplodontia is a very timid animal, but that it will fight fiercely when in a trap. Its clumsy movements seldom permit of its inflicting the injury that its strong jaws and teeth are well fitted to produce. When in pain, milky white tears of a sticky nature cover the small eyes of the creature. A pronounced lachrymal development in a burrowing animal must be a useful feature.

Traps set in aplodontia burrows have caught weasels, skunks (both *Spilogale* and *Mephitis*), mink, and gray fox (Dixon, MS. 1909); and coons (Lord, 1866, pp. 346–358), badgers, wildcats, fishers (Lum, 1878, pp. 10–13), and owls are to be regarded as possible enemies. Red squirrels, rabbits, and ground squirrels share the animals' burrows or forage about their litter.

Cooper (1860, p. 82) says that the school children at Astoria, Oregon, used to catch the awkward creatures by running them down. This may indicate some activity in the daytime for this species. The gait when running is a sort of gallop like that of a bear (Storer, MS. 1915). Observations upon an aplodontia in captivity have shown that the creature runs as easily backwards as forwards; and this faculty must be useful in the narrow burrows.

Economic Importance and Trapping

In a few localities aplodontia does some damage by eating crops and interfering with cultivation at the edges of the fields. Grinnell (MS. 1912) records it as causing trouble along the line of the Union Pacific Railroad over the central Sierra Nevada "by burrowing in the ditch walls." Shelton (MS. 1916) says that, in western Oregon, aplodontia makes itself a nuisance to foresters by undermining trails and causing washouts.

Mountain beaver are easily captured and the usual method of trapping them is to set No. 0 or No. 1 steel traps in the tunnel entrances. The Indians (in Oregon and Washington), says Cooper (1860, p. 82), catch the animals with "stone fall traps." He adds that the skins were not then being bought by the Hudson's Bay Company. Gibbs (*in* Suckley, 1860, pp. 100–106) relates how the Indians, probably the Nisqually tribe in Washington, "trap and eat them and make garments by sewing the dried skins together." The animals were there caught in traps "resembling the figure four trap." Skins of the California species bring only from eight to ten cents in the market, so there is little danger that the mountain beaver will be exterminated as a result of the fur trade.

Aplodontia is not hardy and if injured in the least does not live long in captivity.

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Titles of papers in this volume, and names of new species, are printed in a **bold-faced type**

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